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Historical Development of the U.S. Geological Survey Hydrologic Monitoring and Investigative Programs at the Idaho National Engineering and Environmental Laboratory, Idaho, 1949 to 2001

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Cover: Big Lost River, INEEL diversion dam, and INEEL spreading area A in foreground; INEEL spreading area B and Big Southern Butte in background.
Photograph courtesy of BBWI Photographics.

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By LeRoy L. Knobel, Roy C. Bartholomay, and Joseph P. Rousseau

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U.S. Department of the Interior
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Conversion Factors and Acronyms

Multiply	By	To obtain
acre-foot (acre-ft)	1,233	cubic meter (m^3)
cubic foot per second per mile [(ft^3/s)/m]	0.01760	cubic meter per second per kilometer [(m^3/s)/km]
curie (Ci)	$3.7X10^{10}$	bequerel (bq)
foot (ft)	0.3048	meter (m)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06309	liter per second (L/s)
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
millirem per hour (mr/hr)	0.010	millisievert per hour
picocurie per liter (pCi/L)	.037	brcquerel per liter (bq/L)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula

$$°F = (1.8)(°C)+32.$$

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated units used in report: µg/L (microgram per liter), and mg/L (milligram per liter).

Water year in U.S. Geological Survey reports dealing with surface-water supply is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. Thus, the year ending September 30, 1985, is called the “1985 water year.”

Acronyms

Acronym	Definitions
AEC	U.S. Atomic Energy Commission (changed to ERDA, then DOE)
ANL	Argonne National Laboratory (Illinois)
ANL-W	Argonne National Laboratory-West (INEEL)
ANP	Advanced Nuclear Programs
ANPR	Aircraft Nuclear Propulsion Research
ARA	Army Reactor Area
AREA II	Army Experimental Area II
BG	Burial Ground (now RWMC)
BLR	Big Lost River
BORAX	Boiling-Water Reactor Experiment
CEC	Cation exchange capacity
CFA	Central Facilities Area
CFA LF	Central Facilities Area-Landfill
CPP	Chemical Processing Plant (changed to ICPP, then INTEC)
CTF	Contained Test Facility (formerly LOFT)
DOC	Dissolved organic carbon
DOE	Department of Energy
EBR	Experimental Breeder Reactor
EBR-1	Experimental Breeder Reactor I
EPA	Environmental Protection Agency
ESRP	Eastern Snake River Plain
ESRPA	Eastern Snake River Plain aquifer
ERDA	Energy Research and Development Administration (now DOE)
ETR	Engineering Test Reactor
FET	Fluid Engineering Test (LOFT Facility, formerly FETF)
FETF	Flight Engine Test Facility (now FET)
GCRE	Gas-Cooled Reactor Experiment
GIN	Gas Injection test site
IBO	Idaho Branch Office (of PNR)
ICPP	Idaho Chemical Processing Plant (formerly CCP, now INTEC)
IET	Initial Engine Test

Acronyms—Continued.

Acronym	Definitions
INEEL	Idaho National Engineering and Environmental Laboratory (now INL)
INEL	Idaho National Engineering Laboratory (formerly NRTS, changed to INEEL, then INL)
INL	Idaho National Laboratory (formerly INEEL)
INTEC	Idaho Nuclear Technology and Engineering Center (formerly ICPP)
Kd's	Distribution coefficients
LOFT	Loss-of-Fluid Test Facility (now CTF)
LSR	Large Ship Reactor
MBAS	Methylene blue active substances
MCL's	Maximum contaminant levels
MODFLOW	USGS Modular Finite-Difference Ground-Water Flow Model
MTR	Materials Test Reactor
NPR	New Production Reactor
NRF	Naval Reactors Facility
NRTS	National Reactor Testing Station (changed to INEL)
NTF	Nuclear Test Facility
NTP	Nuclear Test Plant
OFR	Open-File Report
OMRE	Organic-Moderated Reactor Experiment
PBF	Power Burst Facility
PNR	Pittsburgh Naval Reactors (DOE Office)
POC's	Purgeable organic compounds
PSTF	Propulsion System Test Facility
RWMC	Radioactive Waste Management Complex (formerly BG)
SET	Safety Engineering Test
S1W	Submarine Thermal Reactor (formerly STR)
SPERT	Special Power Excursion Reactor Test
STR	Submarine Thermal Reactor (now S1W)
TAN	Test Area North (formerly ANP)
TAN/TSF	Test Area North/Technical Support Facility (formerly TAN)
TRA	Test Reactor Area
USGS	U.S. Geological Survey
WRRTF	Water Reactor Research Test Facility

Historical Development of the U.S. Geological Survey Hydrologic Monitoring and Investigative Programs at the Idaho National Engineering and Environmental Laboratory, Idaho, 1949 to 2001

By LeRoy L. Knobel, Roy C. Bartholomay, and Joseph P. Rousseau

Abstract

This report is a summary of the historical development, from 1949 to 2001, of the U.S. Geological Survey's (USGS) hydrologic monitoring and investigative programs at the Idaho National Engineering and Environmental Laboratory. The report covers the USGS's water-level monitoring program, water-quality sampling program, geophysical program, geologic framework program, drilling program, modeling program, surface-water program, and unsaturated-zone program. The report provides physical information about the wells and information about the frequencies of sampling and measurement. Summaries of USGS published reports with U.S. Department of Energy (DOE) report numbers also are provided in an appendix. This report was prepared by the USGS in cooperation with the DOE

Introduction

In 1949, the National Reactor Testing Station (NRTS), an 890 mi^2 site on the eastern Snake River Plain in southeastern Idaho (fig. 1), was established by the U.S. Atomic Energy Commission (AEC)—which later became the U.S. Department of Energy (DOE)—for the development of peacetime atomic-energy applications, nuclear safety research, defense programs, and advanced energy concepts. The NRTS was renamed the Idaho National Engineering Laboratory (INEL) in 1974 to reflect the broad scope of engineering activities taking place at site facilities. In 1997, the INEL became the Idaho National Engineering and Environmental Laboratory (INEEL) because of additional emphasis on environmental research. Spent nuclear-fuel management; hazardous- and mixed-waste management and minimization; cultural resources preservation; and environmental engineering, protection, and remediation are challenges addressed by current INEEL research activities (DOE–ID, 1996; Becker and others, 1998).

The United States Geological Survey (USGS) has conducted research activities at the INEEL since 1949. USGS personnel traveled from district and regional offices to do investigations until a Project Office was established in 1959 at the Central Facilities Area (CFA, fig. 1) (Rodger Jensen, oral commun., 2000). The USGS still maintains field offices at the CFA, but, since 1998, USGS INEEL Project Office personnel have been stationed at two locations in Idaho Falls, Idaho, and at two locations at Idaho State University in Pocatello, Idaho.

Initially, the USGS was asked to characterize the water resources of the INEEL area before the development of nuclear-reactor testing facilities. The USGS since has maintained ground-water quality and water-level measurement monitoring networks at the INEEL to provide data for research on hydrologic trends and to delineate the movement of facility-related radiochemical and chemical wastes in the eastern Snake River Plain aquifer (ESRPA). The USGS has published many reports on the geology and hydrology of the INEEL. Brief summaries of reports published during 1949–2001 are given in appendix 1.

The USGS, in cooperation with DOE's Idaho Operations Office, has studied the hydrology and geology at the INEEL to better understand the ESRPA system and the effects of historical waste-disposal practices. Wastewater containing chemical and radiochemical wastes was discharged to ponds and wells at the INEEL from the early 1950s until 1983. Since 1983, most aqueous wastes have been discharged to infiltration ponds. Solid and liquid radioactive and chemical wastes have been buried in trenches and pits excavated in the surficial sediment at the Radioactive Waste Management Complex (RWMC, fig. 1). As a result of waste-disposal practices, water from several monitoring wells at the INEEL contains elevated concentrations of several radiochemical constituents, chromium, sodium, chloride, sulfate, nitrate, and purgeable organic compounds (Mann and Beasley, 1994a; Cecil, Frape, and others, 1998; Bartholomay, Tucker, and others, 2000).

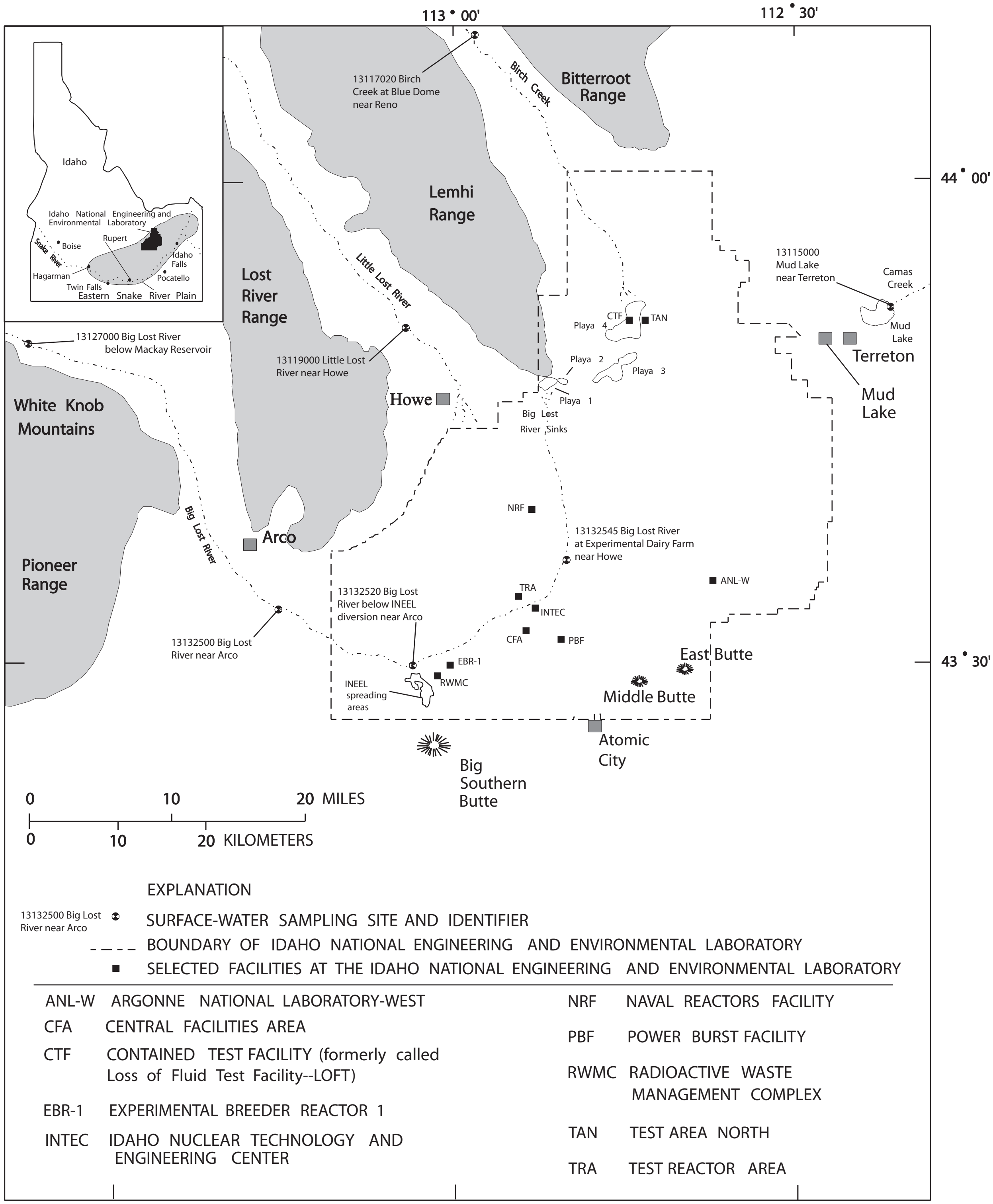

Figure 1. Location of the Idaho National Engineering and Environmental Laboratory, surface-water sites, and selected facilities.

Purpose and Scope

The purpose of this report is to present a summary of the historical development of the USGS hydrologic monitoring and investigative programs at the INEEL. The report covers the time period 1949 to 2001. The development of the water-level program, water-quality sampling program, geophysical program, geologic framework program, drilling program, modeling program, surface-water program, and unsaturated-zone program to their current configurations are discussed. This compilation of information is needed for managerial decisions on future monitoring and investigative programs at the INEEL.

Geohydrologic Setting

The INEEL is on the west-central part of the eastern Snake River Plain (ESRP). The ESRP is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide (fig. 1).

The basin, bounded by faults on the northwest and downwarping and faulting on the southeast, has been filled with basaltic lava flows interbedded with terrestrial sediments. A generalized stratigraphic sequence of rock units was presented by Whitehead (1986). An overview of the basaltic volcanism of the ESRP was presented by Kuntz and others (1992). Individual basalt flows average 20 to 25 ft in thickness with an aggregate thickness of several thousand feet in places. Alluvial fan deposits are composed primarily of sand and gravel; in areas where streams were dammed by basalt flows, the sediments are composed primarily of silt and clay (Garabedian, 1986). Rhyolitic lava flows and tuffs are exposed locally at the surface and may exist at depth under most of the ESRP. A 10,365-ft-deep test hole at the INEEL penetrated about 2,160 ft of basalt and sediment and 8,205 ft of tuffaceous and rhyolitic volcanic rocks (Mann, 1986).

Tertiary and Quaternary volcanic rocks and sediments underlie the ESRP at the INEEL. The volcanic rocks consist of basaltic lava flows, ash and cinders in the upper part of the stratigraphic section and rhyolitic ash flows and tuffs in the lower part (Anderson and Liszewski, 1997). In places, Quaternary rhyolitic domes stand as high as 2,000 ft above the surface of the plain. Volcanic vents for basalt, andesite, and rhyolite are concentrated in a volcanic zone along the axis of the plain and in volcanic rift zones that trend perpendicular to the axis of the plain (Kuntz and others, 1992; Kuntz and others, 1994; Anderson and Liszewski, 1997).

Hundreds of basalt flows, basalt-flow groups, and sedimentary interbeds are present at the INEEL; basalt flows make up about 85 percent of the volume of deposits in the unsaturated zone and aquifer (Anderson and Liszewski, 1997, p. 11). All basalt flows of a group erupted from the same volcanic vent or vents and have similar ages, paleomagnetic properties, potassium contents, and natural-gamma emissions (Anderson and Bartholomay, 1995). The basalt flows, which are locally altered (Fromm and others, 1994), consist mainly of medium- to dark-gray vesicular to dense olivine basalt and are as much as 100 ft thick. Sedimentary interbeds formed between flow groups during periods of volcanic quiescence and are as much as 50 ft thick and consist of well- to poorly-sorted deposits of clay, silt, sand, and gravel of fluvial, lacustrine, and eolian origin (Anderson and Liszewski, 1997). The basaltic rocks and sedimentary deposits combine to form the ESRPA, which is the main source of ground water on the plain.

The ESRPA is recharged by seepage from the upper reaches of the Snake River, tributaries and canals, infiltration from irrigation and precipitation, and underflow from tributary valleys on the perimeter of the plain. Discharge from the aquifer primarily is by pumpage for irrigation and flow from springs to the Snake River (Mann and Knobel, 1990). Discharge from all the springs in the ESRP has fluctuated over the years as a result of changes in water use, irrigation practices, and precipitation (Kjelstrom, 1992, p. 1). About 4.25 million acre-ft of ground water was discharged to springs along the Snake River downstream from Twin Falls in 1998 (Bartholomay, Tucker, and others, 2000).

Recharge to the ESRPA at the INEEL is affected by local surface drainage. The Big Lost River drains more than 1,400 mi^2 of mountainous area that includes parts of the Lost River Range and Pioneer Range west of the INEEL (fig. 1). The average streamflow in the Big Lost River below Mackay Reservoir (fig. 1) for the 82-year period of record (water years 1905, 1913–14, and 1920–98) was 224,900 acre-ft/yr (Brennan and others, 1999, p. 183). Flow in the Big Lost River infiltrates to the ESRPA along its channel and at sinks and playas at the river's terminus. Measured infiltration losses at various discharges range from 1 to 28 (ft^3/s)/mi (Bennett, 1990, p. 1). To avoid flooding at the INEEL facilities, excess runoff has been diverted since 1965 to spreading areas in the southwestern part of the INEEL, where much of the water rapidly infiltrates to the aquifer. Other local surface drainages that provide recharge to the ESRPA at or near the INEEL include Birch Creek, Little Lost River, and Camas Creek (fig. 1).

The ESRPA is one of the most productive aquifers in the United States (U.S. Geological Survey, 1985, p. 193). Movement of water in the aquifer generally is from northeast to southwest. The hydraulic gradient ranges from about 3 to 100 ft/mi and averages about 12 ft/mi (Lindholm and others, 1988). Gradients are smallest in the central part of the plain, which is underlain by a thick section of transmissive basalt (Lindholm, 1991). Water moves horizontally through basalt interflow zones and vertically through joints and interfingering edges of interflow zones. Infiltration of surface water, heavy pumpage, geologic conditions, and seasonal fluxes in recharge and discharge locally affect the movement of ground water (Garabedian, 1986).

At the INEEL, depth to water in wells completed in the ESRPA ranges from about 200 ft in the northern part to more than 900 ft in the southeastern part. Water levels have fluctuated through time because of wet and dry weather periods. Aquifer water levels generally declined at the INEEL from 1987 to 1995 because of drought conditions, have

increased from 1995 to 1999, and have decreased from 1999 to 2001. Water flows southward and southwestward beneath the INEEL at an average hydraulic gradient of 4 ft/mi and ranges from about 2 to 10 ft/mi (Bartholomay, Tucker, and others, 2000). Estimates of ground-water flow velocities at the INEEL, based on the apparent movement of several tracer constituents in the aquifer system, range from about 4 to 20 ft/d (Mann and Beasley, 1994a, p. 24). The range of transmissivity of basalt in the upper part of the aquifer is from 1.1 to 760,000 ft^2/d (Ackerman, 1991, p. 30). The hydraulic conductivity of underlying rocks is several orders of magnitude smaller and ranges from 0.002 to 0.03 ft/d (Mann, 1986, p. 21). The effective base of the aquifer ranges in depth from about 815 to 1,710 ft below land surface in the western half of the INEEL and could be greater than 1,900 ft below land surface in the eastern half (Anderson and Liszewski, 1997, p. 11).

Acknowledgments

The authors gratefully acknowledge all USGS employees and cooperators at the INEEL, both past and present, who collected, compiled, and interpreted data throughout more than 50 years of research; the DOE for providing funding for the USGS research; and Jack T. Barraclough, Rodger G. Jensen, Larry J. Mann, and Warren E. Teasdale, all formerly of the USGS, for their technical reviews of the manuscript.

Historical Development of Hydrologic Monitoring and Investigative Programs

The monitoring networks and programs at the INEEL have evolved over time to their current schedules of monitoring because wells were installed for various reasons at the INEEL; for example, the need to quantify the volume of water in the ESRPA, or the need to determine if the water quality was adequate for industrial use. Well names, locations, well use, well completion and construction data, and pump installation data for selected wells the USGS has routinely sampled or measured as part of its involvement at the INEEL since 1949 are given in tables 1–3 (at back of report) and figs 2–6. The wells designated USGS were installed for specific USGS use to aid with its monitoring activities at the INEEL. Many other wells at the site that were drilled for specific contractor purposes were added to the USGS monitoring network to broaden the regional hydrologic information database. Many well names are derived from facility or proposed facility acronyms. A complete list of current and formerly used INEEL acronyms is available on the internet at: http://www.inel.gov/media/pdf/acronyms.pdf; the acronyms used in this report are listed in the facility-acronym glossary of this report. The following is a synopsis of when and why wells in the current USGS monitoring network were drilled.

The USGS has installed monitoring wells since 1949 for a variety of purposes. Wells USGS 1 through 33 (figs. 2 and 5) were completed in the late 1940s and the early 1950s to establish regional coverage of the INEEL for water-level measurements and water-quality monitoring. USGS 3A and USGS 33 (fig. 2) later were destroyed and USGS 3 and 10 were never completed. During 1954–57, drilling contracts were established to install 15 monitoring wells (USGS 34 through 48, fig. 3) within and south of the Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (ICPP), for monitoring sodium and chloride movement from the ICPP disposal well and for measuring local water-level fluctuations near the INTEC (Peckham, 1959). During 1960–62, several more drilling contracts were established to install more aquifer wells (USGS 49, 51, 52, 57 through 59, 65, 67, 76, 77, 79, 82 through 85, figs. 2 and 3) within, downgradient from, and adjacent to the Test Reactor Area (TRA) and the INTEC. These wells were designed for monitoring water levels and water quality. Additional wells were designed for monitoring perched ground water beneath the TRA waste ponds (USGS 53 through 56, 60 through 64, 66, 68 through 75, 78, 80, fig. 3), and beneath the INTEC (USGS 50 and 81, fig. 3). USGS 86 (fig. 2) was completed in 1966 to add to the USGS regional monitoring coverage at the INEEL. USGS 87 through 90 (fig. 6) were completed during 1971–72 to initiate water monitoring at the RWMC. Several shallow coreholes (USGS 91, 92, 93 through 96, fig. 6) also were drilled and sampled during this period and then later backfilled except, corehole 92, which was used for measuring and sampling perched water. USGS 97 through 99 (fig. 4) were completed during 1973–74 to provide additional monitoring sites downgradient from the NRF (Goldstein and Weight, 1982). USGS 100 and 101 (fig. 2) were completed in 1974 to provide additional monitoring sites downgradient from ANL-W. USGS 103 through 110 (fig. 2) were drilled in 1980 to fill existing gaps in the INEEL hydrologic data base, to determine the subsurface geology near the site's southern boundary, and to determine the southernmost extents of chloride and tritium waste plumes in the aquifer (Lewis and Goldstein, 1982). USGS 110 was later destroyed and redrilled as 110A in 1995. USGS 111 through 116 (fig. 3) were drilled in 1984 to provide additional monitoring sites downgradient from the INTEC. USGS 117 through 120 (fig. 6) were drilled in 1987 to provide additional monitoring sites in the RWMC area. USGS 118 was cored prior to completion. USGS 102 (fig. 4) was completed in 1989 for monitoring water levels and water quality at the NRF. USGS 121 through 123 (fig. 3) were cored in 1989–90 for furthering the geologic understanding of the INTEC area and then later were completed for hydrologic monitoring in the INTEC area. USGS 124 and 125 (fig. 2) were completed in 1993 and 1994, respectively, for monitoring offsite movement of chlorine-36 and tritium and for furthering the understanding of the chemical quality of the water downgradient from the INEEL. USGS 126A, 126B, and 127 (fig. 2) were completed during 1999–2000 to provide additional monitoring sites at the INEEL.

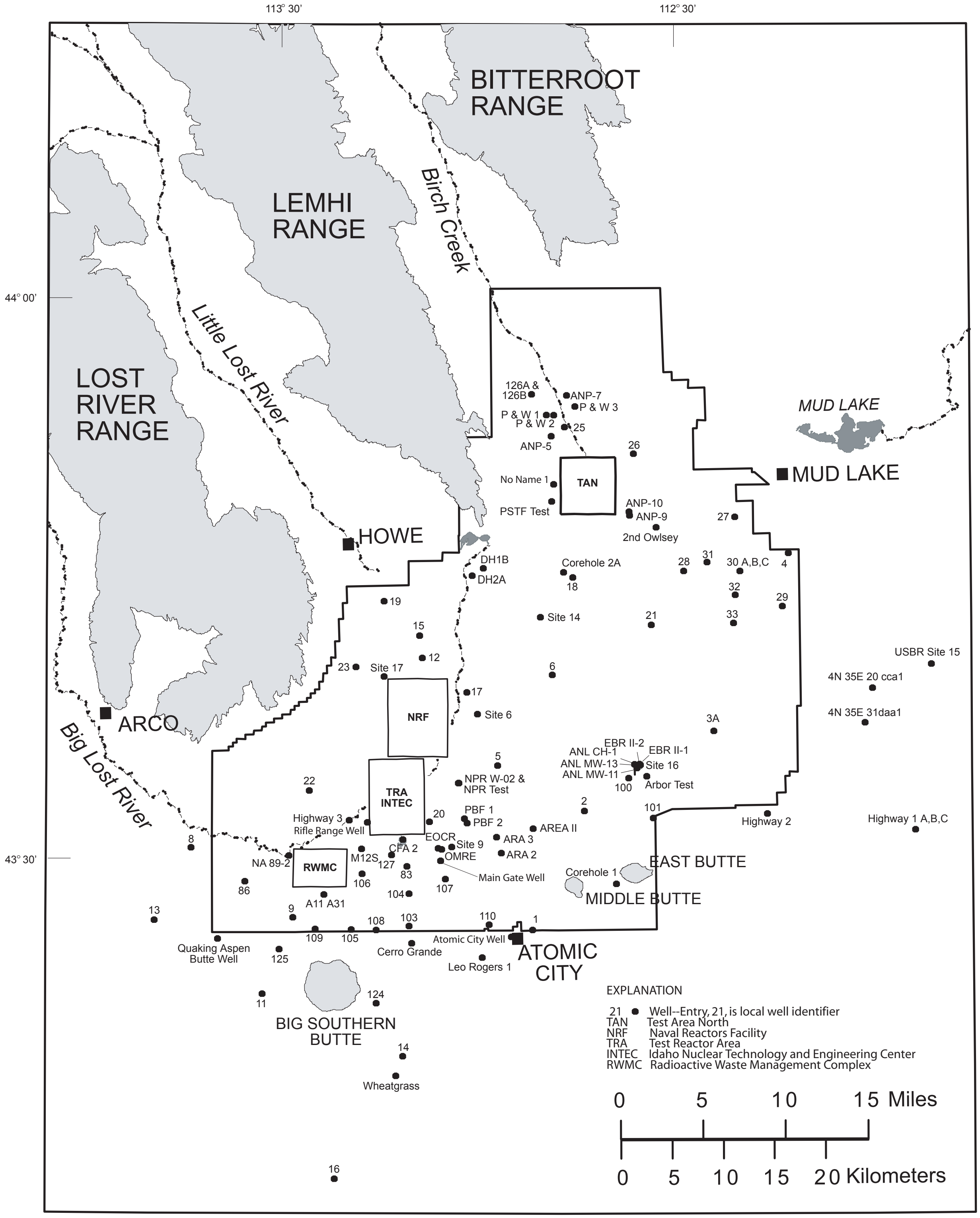

Figure 2. Location of wells sampled or measured by the U.S. Geological Survey between 1949-2001, Idaho National Engineering and Environmental Laboratory.
(Wells designated by numbers are USGS wells; wells beginning with M are RWMC wells.)

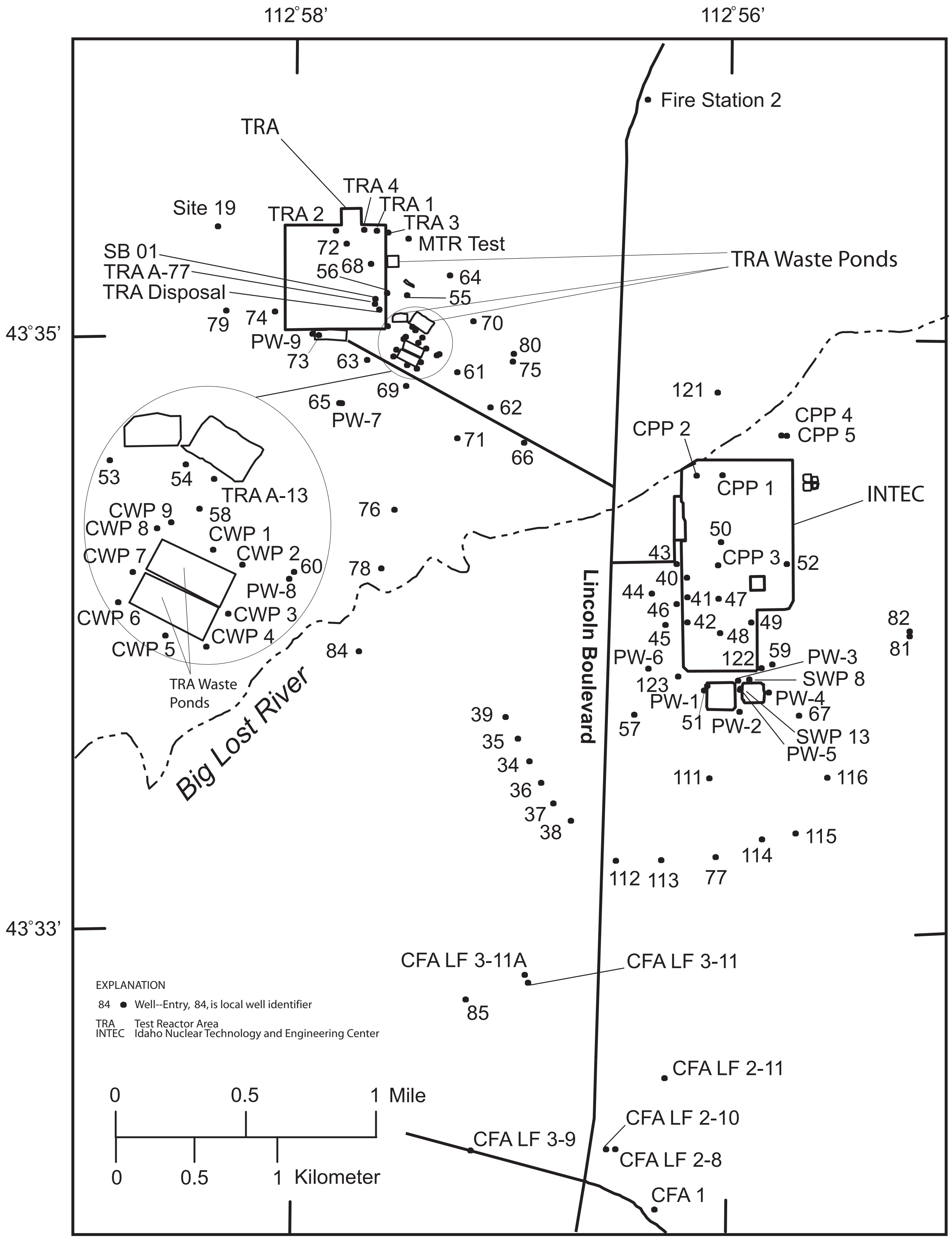

Figure 3. Location of wells sampled or measured in the vicinity of the Test Reactor Area and the Idaho Nuclear Technology and Engineering Center.
(Wells designated by numbers are USGS wells.)

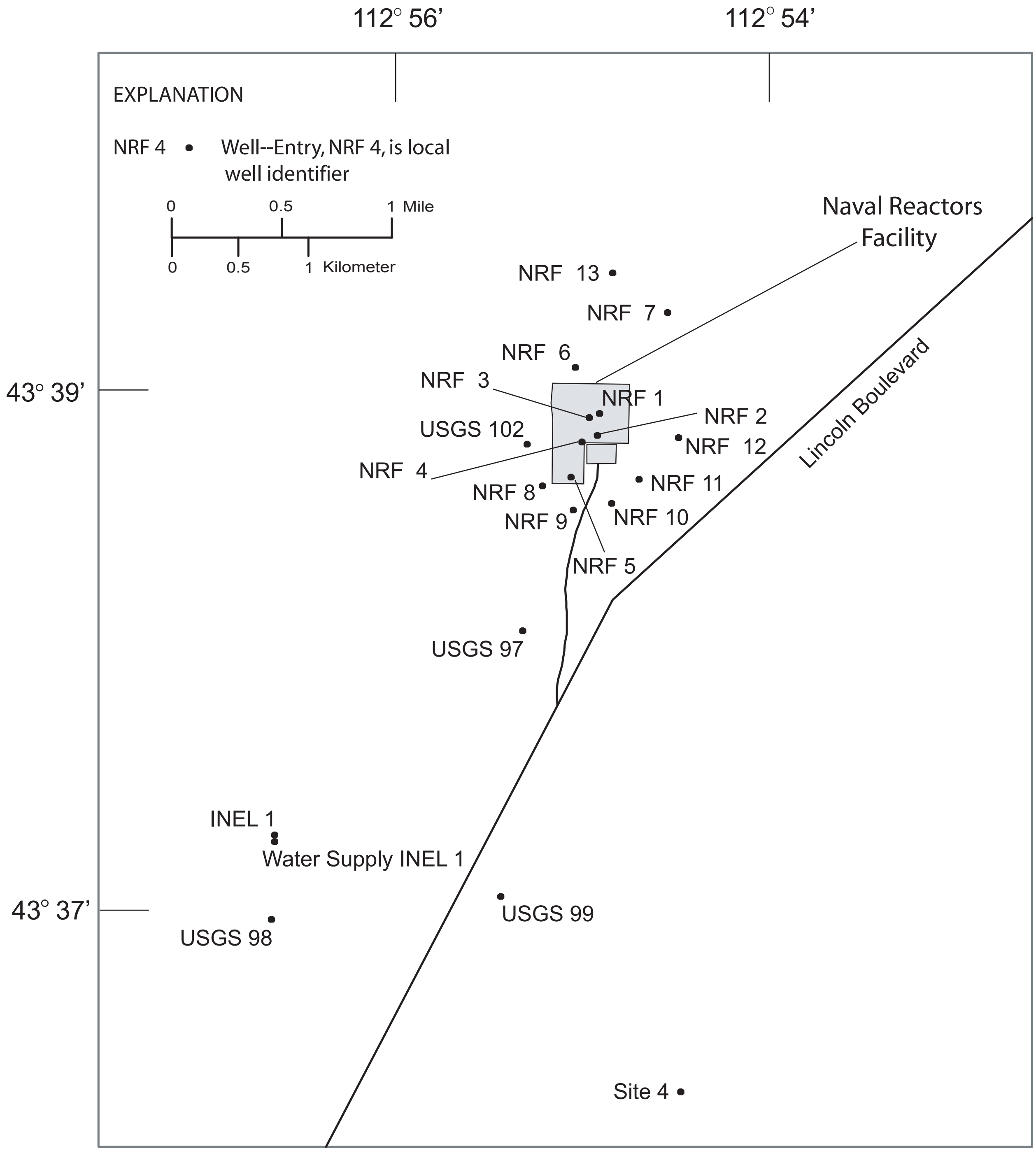

Figure 4. Location of wells sampled or measured in the vicinity of the Naval Reactors Facility.

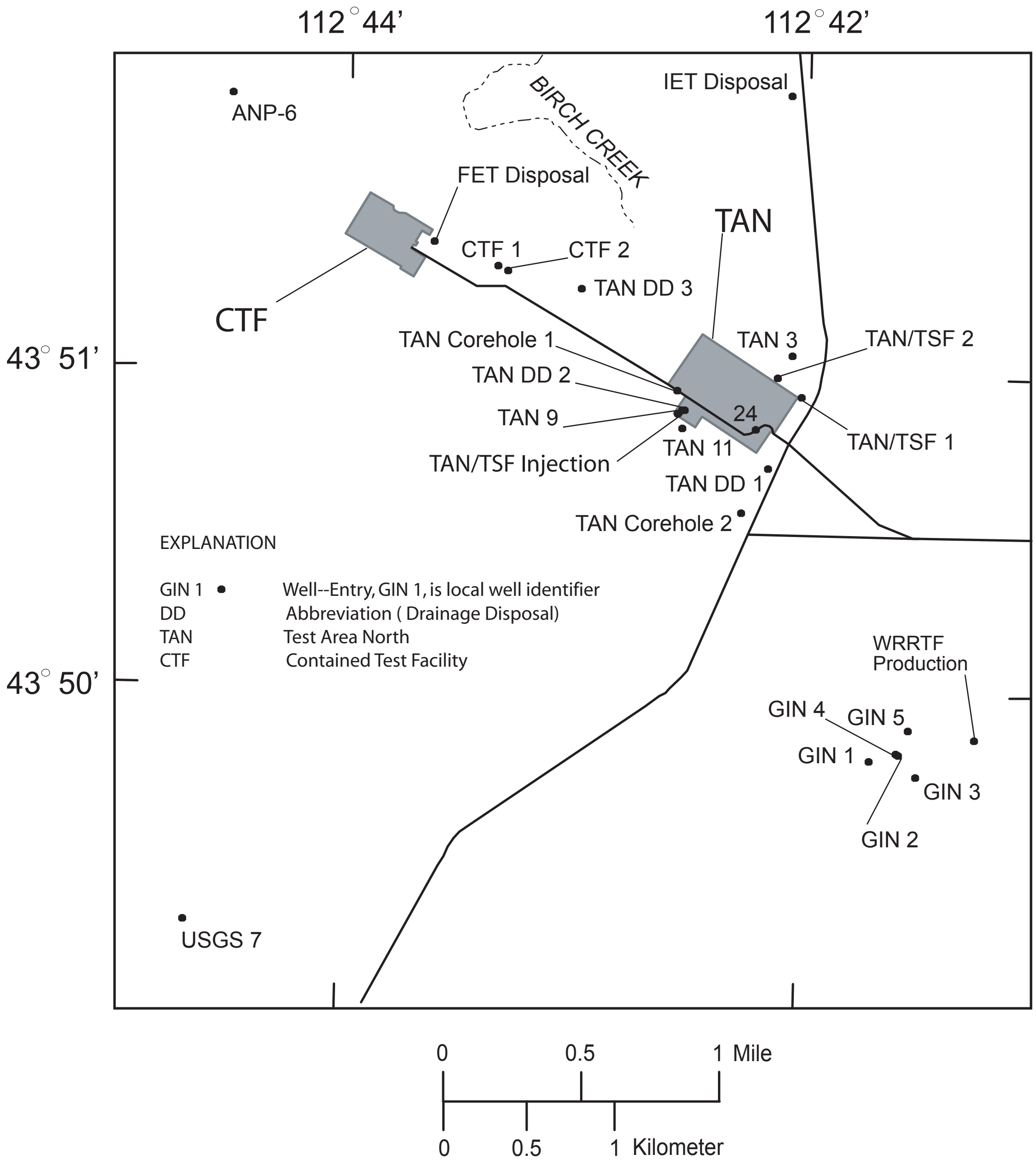

Figure 5. Location of wells sampled or measured in the vicinity of the Test Area North.

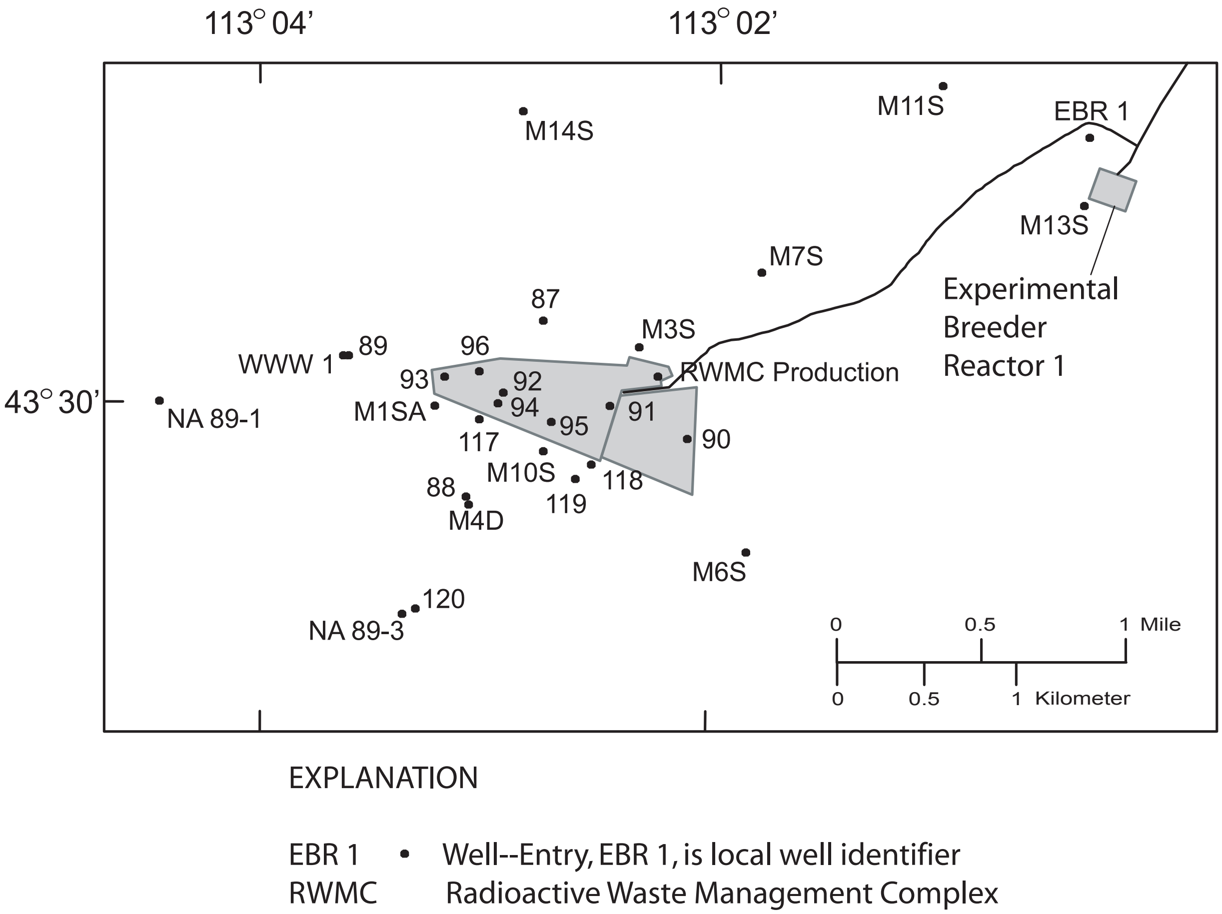

Figure 6. Location of wells sampled or measured at the Radioactive Waste Management Complex. (Wells designated by numbers are USGS wells; wells beginning with M are RWMC wells.)

In addition, the USGS monitors wells installed by others. ANL CH-1, ANL MW-11, and ANL MW-13 (fig. 2) were completed in 1991 at and near Argonne National Laboratory-West (ANL-W) for contractor monitoring purposes. ANL CH-1 was cored prior to completion to provide geologic information for that area of the site. All three wells currently are monitored by the USGS as part of the INEEL regional water-level monitoring program. Wells ANP-1 through -10 (figs. 2 and 5) were completed during 1953–59 to provide geologic and hydrologic information for the proposed Aircraft Nuclear Propulsion Research site, which later became Test Area North (TAN). ANP-1, -2, and -8 were completed as water-production wells and are now respectively known as TAN/TSF 1, TAN/TSF 2, and WRRTF Production. In addition, ANL-3 and ANL-4 are now known as TAN/TSF Injection and IET Disposal, respectively. The others have been used by the USGS since completion for water-level and water-quality monitoring. Arbor Test (fig. 2) was completed in 1957 for hydrologic monitoring near ANL-W. AREA II (fig. 2) was completed in 1960 for water production for a proposed NTP site and has been used by the USGS since completion for water-level and water-quality monitoring. Atomic City Well (fig. 2) was completed in 1952 as a city-supply well and has been monitored by the USGS as part of its regional water-quality monitoring program. Cerro Grande (fig. 2) was completed in 1922 or earlier (Robertson and others, 1974) as a railroad-supply well and has been used by the USGS since 1949 for hydrologic monitoring. CFA 1 and 2 (figs. 2 and 3) were completed in 1943 and 1944 for water production for the Navy and have been sampled by the USGS since the early 1950s. The contractor drilled the CFA LF wells (fig. 3) in the late 1980s to early 1990s for monitoring around the CFA Landfills. The USGS incorporated some of the wells into the water-level and water-quality data-collection programs to provide coverage upgradient from CFA. Coreholes 1 and 2A (fig. 2) were drilled in 1978 to provide deep cores for geologic study of the INEEL. They are used by the USGS for monitoring water-level changes. CPP 1, 2, 4, and 5 (fig. 3) are water-production wells at INTEC and have been sampled by the USGS since their respective installations. CWP 1 through 9 (fig. 3) were completed in 1981 for monitoring shallow perched water that formed from the installation of the cold-waste ponds near TRA in 1982. DH1B and DH2A (fig. 2) were completed in 1984 to study subsurface evidence of faulting and for hydrologic monitoring in the vicinity of the Big Lost River Playas. EBR-1 (fig. 6) was completed in 1949 as a water-supply well for the Experimental Breeder Reactor 1 (EBR-1) facility and has since been monitored for water quality by the USGS. Site 4 (fig. 4) was completed in 1965 as a water-supply well for the dairy farm. Fire Station 2 (fig. 3) was completed in 1957 as a facility water-supply well for Fire Station 2 and was monitored by the USGS until it was decommissioned in 1997. GIN 1 through 5 (fig. 5) were completed in 1964 for a gas-injection study (Morris and others, 1965) and also have been used for water-level monitoring near Test Area North (TAN). Highway 1 and 2 wells (fig. 2) were completed in 1950 as construction-supply wells. Highway 1 was deepened in 1969 and three piezometer pipes were installed for monitoring water levels at different depths. Highway 3 (fig. 2) was completed in 1967 as a supply well for a roadside rest station and is monitored for water quality. INEL 1, a 10,365-ft deep test hole, was completed in 1979 to ascertain whether a hydrothermal resource existed beneath the INEEL and, if so, whether it would be economically feasible to develop the resource (Mann, 1986). It is monitored for water levels. Leo Rogers 1 (fig. 2) was completed in 1966 as a private irrigation well and has been monitored by the USGS as a regional water-quality well. MTR Test (fig. 3) was completed in 1949 as a test well for the proposed Material Test Reactor (MTR) site (now TRA) and has since been monitored for water levels and water quality. The Main Gate Well (fig. 2) was completed as a water-supply well at the main gate and is monitored for water quality by the USGS. NA 89-1 through -3 (figs. 2 and 6) were completed in 1989 as neutron-access holes for monitoring water movement at the spreading areas near the RWMC. NPR Test (fig. 2) was completed in 1984 at a proposed site for a New Production Reactor and has been used by the USGS since then for water-level and water-quality monitoring. NRF 1 through 5 (fig. 4) were completed in the 1950s and 1960s as water-production wells at the Naval Reactors Facility (NRF) and were monitored for water quality by the USGS until 1997. NRF 6 and 7 (fig. 4) were completed in 1991 and NRF 8 through 13 (fig. 4) were completed in 1995 by the NRF contractor for monitoring water quality near the NRF. OMRE (fig. 2) was completed in 1957 as a water-supply well and was monitored by the USGS until the pump failed in 1996. The 2nd Owsley (fig. 2) was drilled in 1928 or earlier and used as an irrigation well. Control of the well was transferred to the USGS and was completed for monitoring in 1949. PBF 1 and 2 (fig. 2) were completed in 1955 and 1960, respectively, as water-supply wells and have been used by the USGS for monitoring at the Power Burst Facility (PBF, formerly the SPERT facility). PSTF Test (fig. 2) was completed in 1957 as a test well for the proposed Propulsion System Test Facility (PSTF) site and has been used since to monitor water levels and water quality. PW-1 through -6 (fig. 3) were cored in 1986 to provide geohydrologic data near the ICPP infiltration ponds and were completed to monitor perched ground water. PW-7 through -9 (fig. 3) were completed in 1986 for monitoring perched ground water near the TRA. P&W 1 through 3 (fig. 2) were completed in 1957 and are used now for water-level monitoring. RWMC M1SA, M3S, M4D, M6S, M7S, and M10S through M14S (figs. 2 and 6) were completed by the contractor during the 1990s for monitoring activities at and around the RWMC. The USGS has collected water samples and water levels at these wells to obtain a better understanding of water quality and water movement at the RWMC. RWMC Production (fig. 6) was completed in 1974 to provide water for the expanding RWMC and since has been monitored by the

USGS for water quality. Sites 6, 9, 14, 16, 17, and 19 (figs. 2 and 3) were completed from 1956 to 1960 as test wells in areas proposed for possible INEEL facilities. These wells have been used by the USGS since completion as regional monitoring wells. SWP 8 and 13 (fig. 3) were completed in 1986 for monitoring shallow perched water at the ICPP infiltration ponds. The contractor completed TAN 3, 9, and 11 (fig. 5) in 1989 to monitor activities at TAN. They were used by the USGS in 1989 and the early 1990s for monitoring water levels in the TAN area. TAN Corehole 2 (fig. 5) was cored in 1990 to provide geologic information for contractor studies at TAN. Two piezometers were completed in the well and the USGS monitors water levels from the piezometers. TAN Drainage Disposal 1 through 3 (fig. 5) were completed in 1967 to provide a disposal medium for surface-water runoff in years of high runoff. The USGS sampled the wells in 1989 as part of a geochemical characterization study (Knobel and others, 1992) and collects surface-water drainage samples during years of high runoff. No Name 1 (fig. 2) was completed in 1963 and currently is monitored by the USGS for water levels and water quality east of the TAN. TRA 1 through 4 (fig. 3) were completed from 1950 to 1963 for water production at TRA; all except TRA 2 are used for water-quality monitoring by the USGS. TRA A-13 and TRA A-77 (fig. 3) are shallow auger holes near the TRA warm-waste pond that were completed for monitoring shallow perched water near the ponds. TRA Disposal, completed in 1963, was used for wastewater disposal until 1982, when it was converted to a monitoring well. Water Supply INEL 1 was completed in 1979 to provide a water supply for drilling activities at the INEL 1 test hole. After drilling was complete, the USGS used the well for measuring water levels and water quality downgradient from the NRF. WWW 1 (fig. 6) was cored to provide geologic data near RWMC and was completed as an unsaturated-zone gas-test well. Wells 4N 35E 20ccal and 4N 35E 31daa1 (fig. 2) are farm wells east of the INEEL used for monitoring water levels starting in 1997.

Water-Level Monitoring Program

The USGS water-level monitoring program originally was designed to identify changes in storage and the general direction of ground-water flow within the ESRPA. The data subsequently has been used to determine hydraulic-gradient changes that affect the rate and direction of ground-water and waste-constituent movement in the ESRPA, to identify sources of recharge to the aquifer, and to measure the effects of recharge. The water-level monitoring program at the INEEL was initiated with the drilling of monitoring wells in 1949. USGS 1 was completed on 12/1/49 (table 2) and has been monitored since for water-level changes in the ESRPA. The water-level monitoring program has expanded as more monitoring wells have been drilled at the INEEL. Barraclough and others (1984) presented water-level data from the ESRPA collected from 1949 through 1982. Ott and others (1992) presented water-level data from the ESRPA collected from 1983 through 1990 from 137 wells. At the end of 2000, water levels in 203 aquifer and perched aquifer wells were measured either annually, semi-annually, quarterly, monthly, or continuously (table 4; at back of report) by the USGS at the INEEL. All USGS water-level data are available on the World Wide Web at http://waterdata.usgs.gov/id/nwis.

Water-Quality Sampling Program

The radiochemical and chemical character of water in the ESRPA is determined from analyses of water samples collected as part of a comprehensive sampling program to identify contaminants and to define the patterns of waste migration in the aquifer. The USGS water-quality sampling program at the INEEL was initiated during 1949–55 with the sampling and analysis of water from several wells for a suite of chemical constituents (Nace and others, 1959; Olmstead, 1962; and Robertson and others, 1974). Periodic sampling for chemical and radiochemical constituents occurred until 1964, when the routine sample collection and analysis (quarterly, semiannual, or annual) began (Rodger Jensen, oral commun., 2000). A description of the movement of waste constituents in the aquifer through time was summarized for 1952 to 1970 by Robertson and others (1974), and the distribution of radiochemical and chemical constituents in the aquifer from 1971 to 1998 are described by Barraclough and Jensen (1976); Barraclough and others (1981); Lewis and Jensen (1984); Pittman and others (1988); Orr and Cecil (1991); Bartholomay, Orr, and others (1995); and Bartholomay, Tucker and others (1997, 2000).

By the end of 2000, 130 wells that penetrate the ESRPA, 40 wells that penetrate perched ground-water zones at the TRA, the INTEC and the RWMC, and 7 surface-water sites were sampled either quarterly, semiannually, or annually as part of the routine sample program at the INEEL (table 5, at back of report). Until 1990, many of the wells were sampled with a thief sampler from an area of active water movement near the top of the aquifer. Beginning in 1990, the USGS installed pumps in most of the wells that are currently in the sampling program (table 3). Numerous constituents have been sampled at wells throughout the history of the INEEL. A historical perspective of selected constituents and gross radioactivity in the ground water follows.

Tritium

The USGS has monitored for tritium at the INEEL since 1956. Tritium, has been, by far, the most abundant radioactive constituent in wastewater discharged at the INEEL, and it is the most widespread radioactive constituent in the ESRPA. About 31,620 Ci was discharged at the TRA and the INTEC through 1998 (Bartholomay, Tucker, and others, 2000). Because of this discharge, tritium has been studied and analyzed more than any other radionuclide at the INEEL.

Hawkins and Schmalz (1965) presented data from 1956, which is the earliest data available, but the first comprehensive study of waste-tritium distribution was conducted by the USGS in 1961 (Jones, 1961; Robertson and others, 1974). High detection limits, around 5,000 pCi/L in 1961 and 1963, were used for tritium analyses because analytical methods for tritium analyses were still being developed (Frederick and Behymer, 1999). The detection limit for tritium improved to 2,000 pCi/L by 1966 (Robertson and others, 1974). Since 1990, tritium concentrations as small as 0.2 pCi/L have been detectable by using an enrichment procedure (Mann and Low, 1994). Tritium typically has been monitored at all the wells that have been or currently are part of the USGS routine sample program (table 5). As of 1996, the USGS had collected 8,142 water samples for tritium analyses from the ESRPA at the INEEL (Frederick and Behymer, 1999, p. 53).

Strontium-90

The USGS has routinely monitored ground water downgradient from INTEC and TRA for strontium-90 since the early 1960s. Strontium-90 has been an abundant radioactive-waste product at the TRA and the INTEC. Bartholomay, Tucker, and others (2000) indicated that about 57 Ci in waste water had been discharged at the INTEC through 1998. About 93 Ci had been discharged to ponds at TRA. The first extensive study of strontium-90 in the ESRP aquifer at and downgradient from these facilities was completed in 1964 (Morris and others, 1965; Robertson and others, 1974). Strontium-90 was monitored at selected wells downgradient from these two facilities through 2001. Detectable concentrations historically have been found in water from several wells downgradient from the INTEC, but no detectable concentrations have been found in ESRP aquifer wells at the TRA. In 1987, a study was done to determine strontium-90 concentrations in the ESRP aquifer across the entire INEEL (Knobel and Mann, 1988). In 1995, strontium-90 was added to analyses requested for annual sampling at several regional wells to verify that regional concentrations were below the detection limit.

Gross Alpha- and Beta-Particle Radioactivity

Gross alpha- and beta-particle radioactivity is a measure of the total radioactivity given off as alpha and beta particles during the radioactive-decay process and has been used to screen for radioactivity in the aquifer as a general indicator of contamination since 1955 (Nace, 1961). Before 1994, gross alpha- and beta-particle radioactivity was monitored routinely in water from three wells west and south of the INEEL and from four surface-water sites. As part of the INEEL ground-water monitoring program adopted in 1994 (Sehlke and Bickford, 1993), the USGS increased the number of wells sampled for gross alpha and gross beta to 43 wells (Bartholomay, Tucker, and others, 1997).

Cesium-137, Cobalt-60, and Chromium-51

The USGS has routinely monitored ground water at the INEEL for gamma radiation since 1962. Gamma spectrometry involves using lithium-drifted germanium detectors to simultaneously determine the concentrations of a variety of radioactive nuclides by the detection of characteristic gamma-emission (Bodnar and Percival, 1982). When a gamma spectrometric analysis is requested, Radiological and Environmental Sciences Laboratory (RESL) currently reports a result for cesium-137, whether or not it is detected, together with any other detectable gamma-emitters. Early studies of gamma radiation in ground water at the INEEL only measured total gamma activity; 725 water samples were collected and measured in 1962 (Morris and others, 1963). Morris and others (1964) gave a more detailed description of the distribution of total gamma activity in ground water at the INEEL. Studies first separating cesium-137, cobalt-60, and chromium-51 from other gamma-emitting isotopes were reported by Robertson and others (1974) and Barraclough and Jensen (1976). Recently, gamma analyses have been requested for samples from selected wells that tap perched water near TRA and from many aquifer wells throughout the INEEL as regional radioactivity indicators.

Plutonium-238, Plutonium-239, -240 (undivided), and Americium-241

Monitoring for plutonium-238, plutonium-239, -240 (undivided), and americium-241 in ground water first occurred in wells at the RWMC in 1971 (Barraclough and others, 1976) and at the INTEC in 1974 (Barraclough and others, 1981). Thousands of curies of plutonium isotopes have been buried at the RWMC, and about 0.26 Ci has been discharged to the disposal well and infiltration ponds at the INTEC (Bartholomay, Tucker, and others, 2000). Since 1974, routine sampling for these isotopes at selected wells has occurred at the RWMC and the INTEC. A regional study done at the INEEL in 1987 (Knobel and Mann, 1988) and geochemical studies done in 1989 and 1991 (Knobel, Bartholomay, Cecil, and others, 1992; Knobel, Bartholomay, Tucker, and others, 1999) also included monitoring for these isotopes.

Iodine-129

The first monitoring for iodine-129 in the ESRPA at the INEEL occurred in April 1977 (Barraclough and others, 1981) at wells at and downgradient from the INTEC. Small concentrations of iodine-129 have been discharged in wastewater from the INTEC since 1952. Additional monitoring by the USGS at wells near the INTEC occurred in 1981 (Lewis and Jensen, 1985) and 1986 (Mann and others, 1988). In 1990–91, Mann and Beasley (1994a) evaluated iodine-129 concentrations in water from 51 wells downgradient from the INTEC. In 1992, the USGS monitored

16 wells, springs, and streams on the ESRP to determine background concentrations of iodine-129 (Mann and Beasley, 1994b). Monitoring for iodine-129 at and near the INEEL also was done in 1995.

Chloride

Peckham (1959) conducted the first extensive study of chloride contamination at the INEEL. Sodium chloride has been the most abundant chemical constituent discharged in wastewater to the subsurface at the INEEL, and consequently, sodium and chloride are among the most widespread chemical constituents in regional ground water (Robertson and others, 1974). Chloride typically has been monitored at all the wells that have been or currently are part of the USGS routine sampling program, and is monitored at all the wells in the current sampling program (table 5). As of 1996, the USGS had collected 5,095 samples for chloride analyses from the ESRPA at the INEEL (Frederick and Behymer, 1999, p. 29).

Sodium

Sodium contamination at the INEEL was first studied extensively in 1958. Sodium chloride has been the most abundant chemical constituent discharged in wastewater to the subsurface at the INEEL, and consequently, sodium and chloride are among the most widespread chemical constituents in regional ground water (Robertson and others, 1974). During the 1950s and 1960s, water samples were analyzed more frequently for sodium than for chloride (Robertson and others, 1974). Since the 1960s, sodium has been monitored less frequently than chloride, but typically has been monitored at least once a year at most of the wells at the INEEL.

Sulfate

Sulfate also has been an abundant constituent discharged in wastewater at the TRA, the INTEC, and the NRF throughout the history of the INEEL; however, USGS monitoring for sulfate has been inconsistent because concentrations generally have been at background levels. Frederick and Behymer (1999) indicated that the USGS did not sample for sulfate during 1964, 1967, 1969, 1973–76, 1980, 1982–83, and 1985. According to L.J. Mann (U.S. Geological Survey, written commun., 1989), sulfate analyses were not part of the routine sample program in the late 1980s. Sulfate analyses at most wells were added to the routine monitoring program in 1995 (Bartholomay, Tucker, and others, 1997).

Chromium

Chromium has been monitored at selected wells at and near TRA since the 1960s (Mann and Knobel, 1988). Many of the INEEL facilities have discharged dissolved chromate wastes at various times, but TRA has discharged more than any other facility (Robertson and others, 1974). Barraclough, Teasdale and others (1967) completed the first extensive study of chromium in the ESRPA at the INEEL in 1966. The USGS analyzed water samples from 81 wells throughout the INEEL for chromium concentrations in 1987 (Mann and Knobel, 1988). Liszewski and Mann (1993) examined chromium concentrations at 138 sites at and around the INEEL with additional sampling in 1990–91. Since the introduction of the INEEL ground-water monitoring program in 1994 (Sehlke and Bickford, 1993), chromium has been monitored at most wells at the INEEL.

Nitrate

Millions of pounds of nitrate has been discharged at the INTEC since 1952 and the first study of nitrate in the ESRPA at the INEEL was in 1973. The study consisted of interpreting analyses of water samples from wells downgradient from the INTEC (Barraclough and others, 1981). The first comprehensive regional study of nitrate was in January 1979 (Barraclough and others, 1981). Since then, annual sampling for nitrate in the regional system has been part of the USGS routine sample program.

Fluoride

About 39,700 lb of fluoride was discharged in wastewater at the INTEC from 1971–98 (Bartholomay, Tucker, and others, 2000), but fluoride analyses were not part of the routine USGS monitoring program until the site-wide ground-water monitoring program was initiated in 1994. It has since been sampled at selected wells near the INTEC. Fluoride was sampled as part of the INEEL geochemical studies completed in the 1950s and 1960s (Olmstead, 1962; Robertson and others, 1974), and in 1989 and 1991 (Knobel, Bartholomay, Cecil, and others, 1992; Knobel, Bartholomay, Tucker, and others, 1999).

Trace Elements

Water samples have been analyzed for selected trace elements, including aluminum, antimony, arsenic, barium, beryllium, bromide, cadmium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium, and zinc, throughout the history of the INEEL as part of several special studies done by the USGS. Early studies that included trace-element analyses were done by Olmstead (1962) and Robertson and others (1974). More comprehensive studies completed in the late 1980s and early 1990s were done by Mann and Knobel (1988), Liszewski and Mann (1993), Knobel, Bartholomay, Cecil, and others (1992), Knobel, Bartholomay, Tucker, and others (1999). As part of the INEEL ground-water monitoring program adopted in 1994, water samples from selected wells in the vicinity of TRA and TAN are analyzed for selected trace elements.

Total Organic Carbon

As part of the INEEL ground-water monitoring program adopted in 1994, the USGS began collecting water samples at selected wells for total organic carbon (TOC) to screen for organic compounds in the aquifer as a general indicator of ground-water contamination. In addition, TOC has been monitored since 1989 at the NRF as part of a special USGS study.

Purgeable Organic Compounds

Leenheer and Bagby (1982) completed the first extensive reconnaissance-level study of purgeable organic compounds (POCs) in 1980. POCs were expected in the ESRPA because of waste-disposal practices at the INEEL. Mann and Knobel (1987) conducted a comprehensive study of POCs at the INEEL in 1987. They used a lower detection level than that of Leenheer and Bagby and were the first to report POCs in water from aquifer wells. Additional studies were completed during 1988–91 (Mann, 1990; Liszewski and Mann, 1992). After the initial discovery of POCs in 1987, the USGS initiated routine monitoring of POCs at wells near the RWMC. Additional routine POC analyses by the USGS were initiated in 1994 as part of the site-wide ground-water monitoring program (Sehlke and Bickford, 1993).

Geochemical Studies

The USGS has conducted interpretive studies to describe processes affecting the distribution of chemical constituents in the subsurface at and near the INEEL. In order to understand the chemical processes controlling the movement of waste constituents, it is necessary to understand the natural geochemical system. The USGS has been collecting ground-water-chemistry data since 1949 (Nace and others, 1951, table 2) and several specific geochemistry studies have been conducted.

To understand the natural geochemistry of the ESRPA system, it is necessary to have a comprehensive understanding of (1) the chemistry of atmospheric recharge to the ESRPA system; (2) the geochemistry of drainages contributing ground- and surface-water recharge to the ESRPA; (3) the physics of ground-water movement and its interaction with surface-water bodies in the ESRPA system; (4) the chemical and physical properties of the gaseous, liquid, and solid phases in the ESRPA system; and (5) the geochemical techniques for describing and modeling the processes taking place in the ESRPA system. Several USGS studies to acquire these types of information are discussed below.

Early Studies

The chemical and physical character of ground water from the INEEL was first described in detail by Olmsted (1962). Olmsted defined four types of ground water at the INEEL, the areal and vertical distribution of selected constituents and physical properties, and the temporal variations in water chemistry resulting from waste disposal.

Robertson and others (1974) described the geochemistry of the INEEL on the basis of data collected during the period 1952–70. They determined areas of recharge to the ESRPA and characterized the water chemistry in those areas. The characterization included identifying geochemical reactions controlling the chemical composition of the recharge water and ESRPA water. They used mineralogy, thermodynamics, and hydrochemical facies in this analysis and described a zone where mixing of the recharge waters occurs.

During the mid-1970s, a study was initiated to formulate a conceptual model of the hydrogeochemical environment of the shallow unsaturated zone of the ESRPA and to determine how changes in that environment could affect the mobility and migration of waste radionuclides buried in the subsurface disposal area (SDA) of the RWMC. The scope of that study included determining (1) particle-size distributions of sediments; (2) the mineralogy of sediments and rocks; (3) the stratigraphy of the ESRPA at the RWMC; (4) the isotopic composition of precipitation, soil water, organic material, and selected solid-phase materials; (5) the ability of geologic materials to adsorb dissolved constituents; and (6) the chemical composition of infiltrating soil water. These data were used to conceptualize weathering reactions and geochemical processes occurring in the unsaturated zone of the ESRPA near the RWMC. Several reports giving the results of that study were published during the 1970s and 1980s (Barraclough and others, 1976; Goldstein and Weight, 1982; Rightmire, 1984; Rightmire and Lewis, 1987a; Rightmire and Lewis, 1987b; and Anderson and Lewis, 1989).

Later Studies

In the 1980s a more comprehensive approach to studying the natural geochemistry of the ESRPA was initiated. The purpose of this study is to systematically compile and interpret data that leads to a more complete understanding of the geochemistry of the ESRPA system. The scope involves describing the source, movement, and fate of elements in the atmosphere, hydrosphere, and lithosphere with specific emphasis on the ESRPA system.

Solid-Phase Studies

The USGS has published several reports describing the mineralogy and chemistry of rocks and soil samples from the ESRPA system. Wood and Low (1988) described average chemical compositions of ESRPA materials and specific chemical and mineralogical compositions of selected ESRPA samples. Bartholomay and others (1989) summarized the information in USGS reports published through 1987 that related to the physical and chemical properties of solid-phase materials in the ESRPA system. Bartholomay and others (1989) also described the grain-size distribution and the bulk and clay mineralogy of surficial sediments from the Big Lost River drainage. Bartholomay and Knobel (1989) provided

the same information for the Little Lost River and Birch Creek drainage, and Bartholomay (1990b) correlated the mineralogy of the surficial sediments in these drainages to the mineralogy of selected sedimentary interbeds in the ESRPA. The mineralogy of interbed samples from the ESRPA at the INEEL was determined by Reed and Bartholomay (1994). The chemical composition of selected basalt samples from the ESRPA at the INEEL were summarized by Knobel and others (1995), and the chemical composition of selected solid-phase samples from the recharge areas of the ESRPA system were summarized by Knobel and others (2001). Anderson and Bartholomay (1995) correlated basalt flows and sedimentary interbeds near the RWMC using geophysical logs and potassium-oxide data, and Reed and others (1997) correlated basalt layers at the INTEC (formerly ICPP) using major-ion and trace-element chemistry. Major-ion and trace-element chemistry data for samples of basalt, sedimentary interbeds, surficial sediments, and fracture- and vesicle-fill materials were summarized by Colello and others (1998), Pace and others (1999), and Liszewski and others (1998; 2000).

Aqueous-Phase Studies

Although water-chemistry data have been collected at the INEEL since 1949, the data collected prior to 1986 were not sufficient for supporting the use of contemporary geochemical models. As a result, a suite of data have been collected specifically for interpretive geochemical models. The requisite data included information on dissolved major ions, dissolved trace elements, stable isotope ratios, unstable constituents, and selected radiochemical constituents. Rightmire and Lewis (1987b) described the chemistry of atmospheric precipitation, perched water, and ground water. Water-chemistry data were tabulated for selected INEEL wells by Knobel, Bartholomay, Cecil, and others (1992) and Knobel, Bartholomay, Tucker, and others (1999); for selected wells downgradient from the INEEL by Bartholomay, Edwards, and Campbell (1992, 1993, 1994a, 1994b), and Bartholomay, Williams and Campbell (1995; 1996; 1997); for selected wells in the Big Lost River drainage basin by Carkeet and others (2001); and for selected wells and surface-water sites by Busenberg and others (2000). Ott and others (1994) described stable isotopes of hydrogen and oxygen for ground- and surface-water samples.

Gaseous-Phase Studies

The studies conducted to acquire water-chemistry data that are discussed in section “Aqueous-Phase Studies” generally contained dissolved-oxygen data and the reports by Rightmire and Lewis (1987b) and Busenberg and others (2000) also contained data on other dissolved gases.

Interpretive Geochemistry Studies

Solid-phase, aqueous-phase, and gaseous-phase data collected during the 1980s and 1990s was collected to support ongoing interpretive studies to describe the natural geochemistry of the ESRPA system. The hydrochemical facies, the thermodynamic properties, and the plausible chemical reactions taking place in the ESRPA at the INEEL were described by Knobel and others (1997). The geochemistry of the Big Lost River drainage basin was described by Carkeet and others (2001).

Special Studies

Special studies have been done throughout the history of the INEEL to resolve issues or to answer questions regarding the natural- or INEEL-influenced water chemistry of the ESRPA, perched-water bodies, or constituent transport in the unsaturated zone. A discussion of some of the most important recent studies (1980–2001) follows.

Site-Wide Reconnaissance Sampling

In August 1980, the USGS initiated a reconnaissance survey of organic solutes in drinking-water sources, ground-water monitoring wells, perched-water monitoring wells, and selected waste streams at the INEEL. Water samples were collected for analyses as follows: DOC in water from 77 wells and 4 potential point sources; insecticides and herbicides in water from 4 wells and several potential point sources; and, volatile and semivolatile organic compounds in water from 14 wells and 4 potential point sources (Leenheer and Bagby, 1982).

To understand the distribution of waste constituents in the ESRPA at the INEEL, another site-wide reconnaissance sampling program was conducted in 1987 by the USGS in collaboration with EG&G Idaho, Inc. Samples were collected from 81 accessible wells (including drinking-water wells) completed in the ESRPA that were equipped with submersible or line-shaft turbine pumps. In addition, a sample from one well completed in a perched-water body at the RWMC was collected using a bailer. Constituents for which samples were analyzed included 36 purgeable organic compounds (Mann and Knobel, 1987); arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, and silver (Mann and Knobel, 1988); and tritium, strontium-90, plutonium-238, plutonium-239, -240 (undivided), americium-241, cesium-137, cobalt-60, and potassium-40 (Knobel and Mann, 1988).

Upgradient Reconnaissance Sampling

Reconnaissance sampling upgradient from the INEEL has been conducted primarily to determine the effects of agricultural activities on the chemistry of water entering the site. Water samples were collected at 13 irrigation, domestic, or livestock wells, and 2 surface-water irrigation canals for analyses of nutrients, herbicides, insecticides and polychlorinated compounds, and surfactants. In addition, samples were collected at one irrigation well, one domestic well, and one irrigation canal for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver (Edwards and others, 1990).

Downgradient Reconnaissance Sampling

In response to concern by citizens in the Rupert area (fig. 1) that high incidence of cancer could be related to contamination of ground water by INEEL activities, the USGS sampled 12 ground-water and 3 irrigation waste-water sites in the eastern part of the A & B Irrigation District, Minidoka County, Idaho (Mann and Knobel, 1990). Samples were analyzed for tritium, gross alpha- and beta-particle radioactivity, total uranium, radium-224, radium-226, radium-228, radon-222, strontium-90, gross gamma radioactivity, specific gamma emitters (lead-212, potassium-40, cesium-137, cobalt-60, and thorium-234), arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, 36 purgeable organic compounds, nutrients, 16 herbicides, 36 insecticides, and 2 polychlorinated compounds (polychlorinated biphenyl [PCB] and polychlorinated napthalenes [PCN]).

To determine whether INEEL activities impacted stock wells immediately downgradient from the INEEL but upgradient from agricultural cropland (an area known locally as "no-man's land"), the USGS sampled five sites (Bartholomay, Tucker, and others, 2001). The samples were analyzed for tritium, gross alpha- and beta-particle radioactivity, strontium-90, plutonium-238, plutonium-239, -240 (undivided), americium-241, gamma-emitting radionuclides, relative concentrations of the stable isotopes of oxygen, hydrogen, and carbon, 9 common ions, 18 trace elements, 4 nutrients, and 63 purgeable organic compounds.

Regional Reconnaissance Sampling

In 1989, concern by the State of Idaho about the U.S. Environmental Protection Agency's (EPA) proposed maximum contaminant level for radon-222 in drinking water prompted the USGS to conduct a reconnaissance sampling of radon-222 in Idaho. During 1989–91, the USGS collected 372 samples from 338 wells and springs in Idaho to provide baseline information about radon-222 concentrations to the State of Idaho and U.S. EPA. The results were summarized by Cecil and others (1994).

In 1990, the State of Idaho requested that the USGS conduct a study to estimate background concentrations of total uranium, radium, radon, transuranic elements, tritium, strontium-90, iodine-129, gross alpha radioactivity, gross beta radioactivity, cesium-137, cobalt-60, potassium-40, nitrate as nitrogen, 12 purgeable organic compounds, 6 pesticides, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and fluoride. The estimated background concentrations were derived from ground-water-quality data collected throughout the State of Idaho (Orr and others, 1991). Because of interest in background concentrations of constituents in Snake River Plain ground water, the estimated concentrations were revised in 1992. The revised estimates were based on data from the ESRPA and excluded INEEL data (Knobel, Orr, and Cecil, 1992).

Global Reconnaissance Sampling

Approximately 80 to 90 percent of the Earth's population live in low- to mid-latitude regions that are subject to environmental changes caused by a variety of natural processes. Studying past environmental conditions of these regions, such as those recorded in annual ice layers in cores recovered from low- to mid-latitude glaciers, can increase the understanding of the potential for future environmental change (Cecil, Green, and Naftz, 2000). In addition to recording naturally occurring past environmental conditions, some low- and mid-latitude glaciers also preserve a record of atmospheric input of constituents from human activities. Increased levels of many modern substances have been detected in glacial ice that is less than about 100 years old. These substances include pollutants from refrigerants, sulfate from acid rain, fallout from nuclear facilities and nuclear accidents around the world, and fallout from the above-ground testing of nuclear weapons that was done in the 1950s and 1960s (Cecil, Green, and Naftz, 2000).

The USGS at the INEEL is conducting studies on a global scale in order to better understand environmental changes and their impacts. Several glaciers have been sampled during this sampling program. The glaciers include (1) Upper Fremont Glacier, Wind River Mountain Range, Wyoming; (2) Inilchek Glacier, Tien Shan Mountains, Kyrghyzstan; and (3) Nangpai Gosum Glacier, Himalayan Mountains, Nepal. In addition to ice cores from the glaciers, several other media have been studied to better understand selected physical and chemical properties in the environment at and near the INEEL. These media include ground water, atmospheric water, vadose-zone water, geologic materials, atmospheric and soil gases, and microbial communities.

Results from global reconnaissance sampling have been presented by Cecil and others (1992, 1996, 1998); Cecil, Green, and others (1999); Naftz and Miller (1992); Thompson (1992); Beasley and others (1993); Naftz (1993); Naftz and others (1993); Cecil and Vogt (1996, 1997); Naftz and others (1996); Paul and others (1996, 1997); Aizen and others (1997); Cecil and Michel (1998); Cecil, Green, and others (1998); Cecil, Green, and Naftz (2000); Davis and others (1998, 2001); Cecil (2000); Cecil, Knobel, and others (2000); Green, Cecil, Naftz, and Schuster (2000); Green, Cecil, Synal, and others (2000); Morin and others (2000a, 2000b); and Schuster and others (2000).

Routine Downgradient Sampling

In 1988, the USGS began collecting samples of spring discharge to the Snake River from 19 sites between Twin Falls and Hagerman, Idaho, for tritium. Results of the sampling program have been presented for 1988–89 (Mann, 1989), 1990–93 (Mann and Low, 1994), and 1994–99 (Twining, 2002).

In 1989, the USGS initiated a routine sampling program in the area from the southern boundary of the INEEL to the Hagerman area, Idaho, known as the Magic Valley. Samples are collected during the summer of each year, and the results are published annually. In 1989, 55 sites were sampled including 26 irrigation wells, 13 domestic wells, 5 springs, 4 stock wells, 3 dairy wells, 2 observation wells, 1 commercial well, and 1 public-supply well (Wegner and Campbell, 1991). The samples were analyzed for radon-222, strontium-90, tritium, gross alpha- and beta-particle radioactivity, total uranium, radium-224, radium-226, radium-228, gamma emitters, 8 trace metals, 4 nutrients, surfactants, 36 purgeable organic compounds, 36 insecticides, gross PCB, gross PCN, and 16 herbicides. In subsequent years, samples from one-third of the 55 sites have been collected and analyzed, so that in every 3-year period, all sites are resampled. Constituent lists are modified slightly, every 3 years, to reflect changes in analytical methods and to avoid collection of samples for constituents not detected in previous samples. Results of the sampling program for 1990–2000 are provided in reports by Bartholomay, Edwards, and Campbell (1992, 1993, 1994a,1994b); Bartholomay, Williams, and Campbell (1995, 1996, 1997, 1998); and Bartholomay, Twining, and Campbell (1999, 2000, 2001).

Facility-Scale Routine Sampling

In 1989, the Idaho Branch Office (IBO) of the Pittsburgh Naval Reactors Office, U.S. DOE, requested that the USGS initiate a water-quality data-collection program in the vicinity of the NRF at the INEEL. The purpose of the data-collection program was to provide the IBO with a consistent set of water-chemistry data to evaluate the effects of NRF activities on the general water quality of the ESRPA. This is an ongoing and long-term program. The original data-collection program consisted of three rounds of sample collection. Round 1 was a one-time sampling of each site for a comprehensive suite of chemical constituents that approximates the EPA’s Ground-Water Monitoring List—Appendix IX (U.S. Environmental Protection Agency, 1989, p. 636–642). Round 2 consisted of five bimonthly samples from each site that were analyzed for the constituents listed in Appendix III-EPA Interim Primary Drinking Water Standards, the constituents listed as parameters establishing ground-water quality, and selected measurements used as indicators of ground-water contamination (U.S. Environmental Protection Agency, 1989, p. 660–661, 730). Additional constituents determined in Round-2 samples included copper, nickel, zinc, and extractable acid and base/neutral compounds. In Round 3, samples were collected quarterly and analyzed for concentrations of chloride, chromium, iron, lead, mercury, nickel, nitrate as nitrogen, silver, sodium, and sulfate. Other Round-3 measurements were gross alpha- and gross beta-particle radioactivity, pH, specific conductance, and total organic carbon. The analytical results for Rounds 1 through 3 are provided in reports by Knobel, Bartholomay, Wegner, and Edwards (1992), Bartholomay, Knobel, and Tucker (1993), Tucker and others (1995), and Bartholomay, Knobel, and Tucker (1997). An analysis by Westinghouse Electric Corporation of the water-chemistry data collected for the NRF monitoring program during 1989–95 indicated that several changes to the program would improve the overall usefulness of the data. As a result, several older wells were eliminated from the program and replaced by monitoring wells specifically constructed to meet the NRF needs and strategically placed to better intercept chemical plumes in the ground water. To differentiate between the data generated in Rounds 1 through 3 (1989–95), the samples collected in 1996 were designated as Round-4 samples. In addition to changing the locations of sample collection, the list of constituents for analysis in Round-4 samples was modified. The Round-4 samples were collected quarterly and the results of the analyses were presented by Knobel, Bartholomay, Tucker, and Williams (1999). At the end of 1996, the NRF increased its validation requirement for ground-water data on the basis of documents that supported the Record of Decision for the industrial-waste ditch and the NRF landfills. The additional cost for the USGS National Water Quality Laboratory was too great to supply the required documentation. Consequently, NRF personnel sampled the wells during the first quarter of 1997. After further consideration of the program, it was determined that the samples could be collected under the USGS Department of Defense Environmental Conservation Program. Under this program, analyses of samples were contracted to Quanterra Environmental Laboratory Services, a laboratory that routinely handles documentation requirements of regulatory programs. Starting in June 1997, analyses of water samples collected quarterly by the USGS were analyzed by the Quanterra laboratory. Because of the change in laboratories, the constituent list also was modified slightly. To differentiate water-quality samples collected after 1996 from those collected previously, the samples were designated as Round-5 samples. Results of analyses for Round-5 samples collected during 1997–99, are given in reports by Bartholomay Knobel, and others (2000; 2001).

Quality-Assurance Practices

Water-quality sampling techniques used by USGS personnel are specified by the USGS Office of Water Quality, and are documented in appropriate USGS publications such as the Techniques of Water-Resources Investigations series. USGS-approved water-quality sampling techniques have been used at the INEEL since water-quality activities were first initiated. Currently used techniques are documented in a report by Wilde and others (1998) and in auxiliary documents such as the USGS Idaho District Office’s Quality Assurance Plan for water-resources activities of the USGS in Idaho (Packard, 1996) and the Quality-assurance plan and field methods for quality-of-water activities, USGS, INEEL,

Idaho (Mann,1996). The quality-assurance program of the USGS INEEL Project Office that was described by Mann (1996), associated evaluations of field-sampling methods and laboratory-analytical methods, and statistical comparisons of analytical results for paired quality-assurance samples are summarized briefly below.

Quality-Assurance Program of the USGS INEEL Project Office

In order to better document the quality of data collected by USGS personnel at the INEEL, a formalized chain-of-custody system was implemented in September 1987. Since that time, the USGS has tracked every sample from collection to delivery to the analytical laboratory. In addition, a field logbook has been used to record all pertinent information about the sample and the prevailing conditions during the sample collection process. These documents are permanently stored at the USGS INEEL Project Office along with the original data records that were generated as a result of the sampling activities. These records are available for inspection upon request.

The components of the quality-assurance program (Mann, 1996) include: (1) a statement of the purpose of the program and a designation of responsibility for administering the program; (2) a statement of the program scope, including a description of the monitoring network, sampling schedule, and data-quality objectives; (3) a detailed description of the methods used for sample collection, preservation, storage, and shipping; (4) a description of decontamination procedures and of field equipment used for sample collection; (5) a description of analytical methods used and the types and frequencies of quality-control samples; and (6) a system for reviewing analytical results, conducting performance audits, taking corrective actions, and reporting of data. The quality-assurance plan also provides samples of forms required for sample collection, shipping, and analysis, and tables of site-specific information for use by field personnel.

Studies Evaluating Field-Sampling and Laboratory-Analytical Methods

When changes to national guidelines are necessary, the INEEL Project Office conducts studies to evaluate the effects of these changes and to demonstrate whether there is continuity in the data resulting from these changes. Physical and chemical characteristics of an aquifer that are locally unique may necessitate changes in sampling methods originally designed for use under different conditions. Changes in analytical methods also may result from improvement of analytical equipment.

The USGS at the INEEL has conducted several studies to evaluate sample-collection and laboratory-analytical methods. Reports generated from results of these studies include an evaluation of field-sampling and preservation methods for strontium-90 (Cecil and others, 1989; Knobel, Cecil, and others, 1992), a comparison of different pump types used for sampling purgeable organic compounds (Knobel and Mann, 1993), an analysis of tritium and strontium-90 concentrations in water from wells after purging different borehole volumes (Bartholomay, 1993), an analysis of the effect of different preservation methods on nutrient concentrations (Bartholomay and Williams, 1996), and an analysis of two analytical methods for determining gross alpha- and beta-particle radioactivity (Bartholomay, Hill, and Randolph, 1999).

Statistical Comparisons of Paired Quality-Assurance Samples

Ten percent of the samples collected by the USGS INEEL Project Office are quality-assurance samples and a large proportion of these samples are replicate samples. A replicate sample is collected immediately following the routine sample, assigned a unique identification number, and sent to the same laboratory as the routine sample for analysis. A duplicate sample is collected in the same way but is sent to a different laboratory for analysis. Split samples are derived from a large volume of water that is collected and preserved and then split into two or more samples. The split samples then are sent to one or more laboratories for analysis. The data are available from the USGS INEEL Project Office. The analytical results for these different types of paired samples should be the same.

The analytical results for the paired samples are compared statistically using methods described by Wegner (1989) and Williams (1996). The comparisons of all paired quality-assurance samples collected by the USGS INEEL Project Office are provided in a series of reports (Wegner, 1989; Williams, 1996, 1997; Williams and others, 1998; Knobel, Bartholomay, Tucker, and Williams, 1999; Knobel, Bartholomay, Tucker, and others, 1999; Carkeet and others, 2001).

Geophysical Program

Subsurface Geophysical-Logging Program

Many geophysical well logs, including neutron, gamma-gamma (density), gamma, caliper, temperature, resistivity (electric), specific conductance, magnetic, deviation, video, and flowmeter, have been run by the USGS since 1952. The first gamma logs were run in 1952 and 1953 and the results were presented by Nace, Deutsch, and others (1956). In 1957, additional gamma logs were run on some selected wells.

In 1963, an experimental logging tool—the Tracejector—was tested at the INEEL for measuring velocity and direction of flow in a borehole. The method consisted of injecting Iodine-131 into the borehole and tracking its movement with a gamma-ray logging tool. The results were presented by Morris and others (1964). The “Tracejector” also was used at the ICPP area in 1965, and the results were presented by Barraclough, Teasdale, and Jensen (1967).

In 1960, the USGS began logging all the existing wells at the INEEL that could be logged and has since operated geophysical logging support for most drilling activities at the INEEL. A list of all logs that the USGS ran before August 1989 and digitized copies of many logs were presented by Bartholomay (1990a). Before 1991, logs were available only in paper copy; in 1991, new logging equipment allowed the USGS to save all logs in electronic format. Geophysical logs are available from the USGS INEEL Project Office.

Surface Geophysics Program

From the 1960s through the 1980s, a body of data was collected by USGS personnel at the INEEL using surface geophysical techniques. The types of data and interpretations are summarized below.

Electrical Resistivity Studies

A suite of electrical-resistivity profiles have been conducted to determine basalt thickness in the Snake River Plain. These profiles were discussed in detail by Whitehead (1992).

Gravity and Aeromagnetic Surveys

Geophysical data from gravity surveys and aeromagnetic surveys were collected in the early 1960s. Results include a generalized Bouger gravity anomaly map, a preliminary aeromagnetic traverse flown at 500 ft, and aeromagnetic profiles along five different flight lines. The gravity and aeromagnetic data were used to formulate a conceptual model of the Little Lost River drainage at its mouth, and to prepare maps depicting regional physiographic features, generalized stratigraphic cross sections at and north of the INEEL, and areas of intense regional faulting. The data also were used to delineate locations of a ground-water barrier, lineaments, and faults in basalt at the INEEL. These results were reported by Morris and others (1964; 1965). Additional data was reported in the 1970s and 1980s by Mabey (1978; 1982) and Mabey and others (1974). The 1974 data were used in conjunction with data published by Berg and Thiruvathuskal (1967) to prepare a gravity model of the Snake River Plain. This model was summarized by Whitehead (1992).

Aeroradioactivity Survey

An aeroradioactivity survey was conducted in 1964 and the results were used to prepare maps showing basalt types and relative ages at the INEEL and surrounding areas (Morris and others, 1965).

Seismic Studies (Reflection and Refraction)

A borehole refraction study using 96 geophones was done in 1964 between wells USGS 31 and 33. The results of this study, conclusions regarding low- and high-frequency seismic refraction techniques and special reflection techniques, were presented by Morris and others (1965). In addition, seismic refraction studies were done at the Gas Injection site near TAN and the results (depth to basalts) were presented by Barraclough, Teasdale, and others (1967). Whitehead (1992) used data from a seismic-refraction study by Sparlin and others (1982) to hypothesize that a deeply buried rock body of different lithology underlies the Snake River Plain. Barraclough, Teasdale, and Jensen (1967) reported on a study of earthquake-induced water-level changes in INEEL wells and recommended installing seismic stations at the INEEL.

Geologic Framework Program

The USGS has conducted studies to describe the geologic framework at the INEEL since the site was established in 1949. These studies have been done to assist in facility design and construction, to locate reliable water-supply sources, to evaluate waste-management scenarios, and for a variety of other reasons.

Surface Geology Mapping

An understanding of local geology is important for stewardship of natural resources. Personnel from the USGS's INEEL Project Office and Geologic Division have mapped the surface geology of the INEEL and adjacent areas since 1949 at the facility scale and at the INEEL-wide scale. It is not feasible in this report to describe all of the facility-scale mapping studies; however, these studies have been incorporated into surface geologic maps of the INEEL, which have been updated periodically as new data has been acquired. The first comprehensive surface geology map was published by Nace, Deutsch, and Voegeli (1956) and was based on a compilation of data collected up to that time. Nace, Deutsch, and Voegeli (1956) also provided detailed descriptions of the geologic units that were mapped and the general geology and geography of the INEEL. Surface geophysical data collected in 1964 (Morris and others, 1965) were used to update the map published by Nace, Deutsch, and Voegeli (1956). Morris and others (1965) also provided descriptions of the mapped geologic units. Extensive age-dating and field geology data were collected before 1964, and these data were used to prepare a preliminary geologic map of the INEEL (Kuntz and others, 1984). The most recent geologic map of the INEEL prepared by the USGS (Kuntz and others, 1994) was an updated version of the 1984 preliminary map and gave a detailed and comprehensive description of the geology of the INEEL.

Subsurface Stratigraphic Correlation

Many geophysical tools have been used at the INEEL to gain better understanding of the subsurface geologic framework of the ESRPA. Surface geophysical tools were used extensively during the 1960s and 1970s to provide preliminary information on the stratigraphy of the ESRP (see

section “Surface Geophysics Program”). After a large number of borehole geophysical logs became available, it was possible to use the logs and additional supporting data to make detailed correlations of subsurface stratigraphic relations.

Beginning in the late 1980s and continuing through the 1990s, a systematic program to describe the subsurface stratigraphy of the ESRP at the INEEL was initiated. Studies were conducted at the facility scale and at the INEEL-wide scale. Results of these studies were provided by Anderson and Lewis (1989) for the unsaturated zone at the RWMC, by Anderson (1991) for the unsaturated zone and uppermost part of the ESRPA at the INTEC and TRA, by Anderson and Bowers (1995) for the unsaturated zone and uppermost part of the ESRPA at TAN, and by Anderson and Liszewski (1997) for the unsaturated zone and the ESRPA at and near the INEEL.

Additional information that was used in these correlations included petrographic descriptions of core samples, radiometric age dating of core samples, and paleomagnetic data from oriented basalt-core samples (Kuntz and others, 1980; Lanphere and others, 1993). Chemical composition of basalt flows (Reed and others, 1997) and natural-gamma logs and cores of basalt and sediment (Anderson and Bartholomay, 1995) also were used as additional supporting data for stratigraphic correlation.

Several studies related to those described above were done in the 1990s. Anderson, Ackerman, and others (1996) published stratigraphic data for wells at and near the INEEL; Anderson, Liszewski, and Ackerman (1996) estimated the thickness of surficial sediment at and near the INEEL; Anderson, Liszewski, and Cecil (1997) determined geologic ages and accumulation rates of basalt-flow groups and sedimentary interbeds in selected wells at the INEEL; and Anderson, Kuntz, and Davis (1999) discussed geologic controls of hydraulic conductivity in the ESRPA at the INEEL.

Core Library Activities

In 1990, the INEEL Lithologic Core Storage Library was established by the USGS to consolidate, catalog, and permanently store nonradioactive drill cores and cuttings obtained during investigations of the subsurface at the INEEL and to provide a location for researchers to examine, sample, and test these materials. The availability of core material for study and the procedures for using the Core Library were described by Davis and others (1997).

Drilling Program

When activities at the INEEL began in 1949, it was necessary to install wells for determining the quantity and quality of the water supply and to acquire information about the engineering characteristics of the subsurface at potential facility construction sites. To address this need, the USGS and the AEC initiated a well-construction program. Well-drilling companies were contracted to do the work under the supervision of the USGS or Torkleson Engineers. Several reports documenting the early well-drilling activities are summarized in appendix 1 of this report. A few examples are reports by Jones and Voegeli (1951a, 1951b), Jones, Duetsch, and Voegeli (1951), Nace and Voegeli (1951), Peckham, Houston, and Walker (1959), and Goldstein and Weight (1982).

Well Drilling Activities

In the 1980s, the USGS research drilling team located in Denver, Colo. conducted research drilling near the RWMC and the NRF. Three neutron-access holes near the RWMC were installed as a result of these activities. In 1989, the research drilling team conducted an experimental suction-drilling study to determine the feasibility of using this method at the INEEL (Teasdale and Pemberton, 1990). In 1990, the USGS research drilling team and equipment were transferred to the USGS INEEL Project Office to conduct research drilling at the INEEL. From 1990 through 1997, USGS drilling activities at the INEEL were mostly well rehabilitation and installation of research wells.

Core Drilling Activities

The USGS has contracted drilling to include core recovery at the INEEL throughout the history of the site. Several reports in appendix 1 document these activities. The report by Rightmire (1984) is an example of the type of information collected during contracted coring operations. Although the drilling equipment acquired in 1990 could be used to retrieve core from wells, it was not well suited for this activity. In order to support new research initiatives in the unsaturated zone at the INEEL, the USGS purchased new drilling equipment in 1998 that was better suited for core recovery for research activities such as those referred to in the section “Unsaturated Zone Program.” Since 1998, eight research coreholes have been completed in this program.

Modeling Program

Historical concerns by DOE, the State of Idaho, and the citizens of Idaho about the behavior and movement of water, gas, and solutes in the ESRP aquifer have generated modeling studies by the INEEL Project Office that attempt to describe and evaluate the physical and chemical processes that control this behavior and movement.

Gas Transport Model

To evaluate the potential of the unsaturated zone overlying the ESRPA as a potential repository for direct discharge of gaseous radioactive-waste constituents, an injection test was done to determine the effects of molecular dispersion and barometric pressure on the vertical movement of Xenon-133 (Xe-133). A simple numerical method

combined with a finite grid system was used to estimate diffusion rates at each grid point for various times, and these were integrated areally over the period of the test. Similar estimates of the material-balance inventories and barometric-pressure effects were determined, and all three were compared with ground-surface flux rates of Xe-133 that were measured in the field. The results of this modeling study were presented by Robertson (1969).

Geochemical Models

Graphical techniques of describing water chemistry data were used by Olmsted (1962) to define four types of ground water at the INEEL and to identify areas of the ESRPA that were affected by waste-disposal operations.

Thermodynamically coupled reaction models were formulated in two studies by the USGS. Robertson and others (1974) developed a series of reaction models to help describe differences in water chemistry in areas that recharge the ESRPA, and constructed a thermodynamic model (with respect to the reaction models) to determine if the reaction models were consistent with the observed water chemistry. Knobel and others (1997) developed a preliminary set of reaction models coupled with thermodynamic modeling of the ESRPA (relative to the reaction models) for use in future geochemical modeling of the ESRPA.

The thermodynamically coupled reaction models developed by Robertson and others (1974) and Knobel and others (1997) were combined with a conservation-of-mass approach to study the geochemistry of three valleys tributary to the ESRPA (Carkeet and others, 2001; Swanson, 2002; Swanson and others, 2002; Swanson and others, 2003). These geochemical-modeling studies used modifications of the previously formulated reaction models coupled with water-chemistry data from the tributary valleys, mineralogy data, and mass-balance techniques to define the geochemical systems in the valleys and to describe the chemistry of water from each valley that contributes recharge the ESRPA at the INEEL.

During the 1980s, Rightmire and Lewis (1987b) developed a conceptual geochemical model of the unsaturated zone at the RWMC. They used data on the subsurface geology (Rightmire and Lewis, 1987a) and data on stable isotopes to formulate several hypotheses for testing. The hypotheses involved origins of the water infiltrating through the unsaturated zone and recharging the ESRPA, and the climatic conditions existing during the formation of clay minerals.

During the 1990s, a study was conducted that used chlorofluorocarbons, sulfur hexafluoride, and dissolved permanent gases in the unsaturated zone and ground water of the ESRPA to model the age and source of the young fraction of ground water at the INEEL. The methods and results of this study were published in several reports by Busenberg and others (1993; 1998; 2000; 2001).

Elemental chemistry of whole-rock samples was used in conjunction with the neutron-producing capabilities of radioactive elements to model the production of Cl-36 in ground water. Free-neutron capture by dissolved Cl-35 forms dissolved Cl-36. Calculating the flux of neutrons produced by ESRPA rocks allows for the estimation of in situ production of Cl-36 and its effect on background concentrations of the radionuclide in ESRPA ground water (Cecil, Knobel, and others, 2000).

Ground-Water Flow and Solute-Transport Models

Several analog models and computer codes that approximate solutions to the mathematical equations describing ground-water flow and solute transport are available. The computer codes effectively have replaced analog models and have been substantially improved over time. Several of the computational computer codes have been used to study the hydrology of the ESRPA.

Ground-Water Flow Models

In order to understand ground-water flow at the INEEL, it is necessary to have a framework of understanding of the larger regional ground-water flow system of the ESRPA. During the 1980s, the USGS initiated a study to evaluate ground-water flow in the ESRPA and the results of that study are presented in a report by Garabedian (1992). Several modeling studies evaluating ground-water flow at the INEEL and in adjacent areas were initiated prior to 2001. These include a conceptual model, a steady-state model, a transient model, and a solute-transport model. The study area of these models is smaller than, but included in, the study area of the model reported by Garabedian (1992).

Ackerman (1994) used an advective transport particle-tracking package described by Pollock (1989) in conjunction with results from Garabedian (1992). The work included: (1) descriptions of compartments in the aquifer that function as intermediate and regional flow systems, (2) descriptions of pathlines for flow originating at or near the water table, and (3) quantitative estimates of traveltimes for advective transport originating at or near the water table.

Several smaller flow models developed for areas at and near INEEL facilities were used to study the behavior of flow in the unsaturated zone at the INEEL. Conclusions regarding the occurrence of perched-water bodies, the horizontal movement of water in the perched-water zones, and the vertical movement of water to the ESRPA are provided in reports by Naylor (1988), Norton (1990), and Orr (1999). The model described by Orr (1999) required modification of the USGS modular finite-difference ground-water flow model (MODFLOW) to accommodate the conversion of no-flow cells to variable-head cells. The modification of MODFLOW is documented in a report by McDonald and others (1991).

Solute-Transport Models

Robertson (1974) formulated one of the first comprehensive numerical transport-modeling studies. Using INEEL data collected from about 1950 through 1972, he calibrated a two-dimensional flow-and-transport model, and made predictions about solute spreading to the year 2000. The calibrated longitudinal and transverse dispersivities were about 300 and 450 ft, respectively. A transverse dispersivity larger than longitudinal dispersivity was theoretically unexpected and unique among field-scale case studies. This unusual relation of transverse and longitudinal dispersivity generated subsequent studies to evaluate the causes of this apparent anomaly. Lewis and Goldstein (1982) compared Robertson's 1980 predictions with 1980 measured concentrations. They noted differences in the spreading and rate of front movement and hypothesized possible reasons for these differences, such as fluctuations in recharge. Goode and Konikow (1990) conducted a modeling study to determine the effects of transient flow on dispersivities at the INEEL, and Cecil, Welhan, and others (2000) used a one-dimensional model coupled with Cl-36 arrival times at distant wells (about 15 mi) to reevaluate dispersivities and estimate flow velocities at the INEEL.

Robertson (1977) used a numerical model of the unsaturated-zone at the TRA to study (1) the vertical movement of solutes from the seepage ponds to the underlying perched-water body, (2) the horizontal transport of solutes in the perched-water body, and (3) the vertical movement of solutes from the perched-water body to the ESRPA. This modeling study used a combination of finite-difference methods and analytical modeling solutions to evaluate solute transport at the TRA.

Surface-Water Program

The USGS surface-water data for the INEEL generally have been summarized as a section of the USGS annual progress reports or as part of the hydrologic update reports. For an example of surface-water reporting in these reports, see Barraclough, Teasdale, and Jensen (1967). More specialized surface-water program activities are discussed in the following sections.

Big Lost River Stream-Gaging Program

Stream gaging on the Big Lost River began prior to the establishment of the INEEL. Summaries of stream-gaging activities on the Big Lost River can be found in early INEEL reports (Nace and Barraclough, 1952; Travis, 1954, 1955; Lamke, 1969). In 1984, the USGS began operating six continuous and nine partial-record stream gages on the Big Lost River to determine transmission losses of the main channel and diversions, to estimate infiltration in ponded areas, and to aid in flood-control studies. Discharge is measured routinely at the gages to define the relation between the water-surface altitude and the discharge of the streams. The transmission losses and infiltration rates are used to calculate the volume of water that is recharged to the ground-water system. Flow records of these stations are published annually in the USGS Water-Data Report Series, Volume 1, for the appropriate water year. For example, for water year 1995, the discharges were published in the water-data report by Brennon and others (1996). A statistical summary of streamflow data for the INEEL and vicinity through 1990 was provided by Stone and others (1992). Daily flow values, annual peak flows, and statistical summaries are available in the USGS database NWIS and can be accessed on the World Wide Web at http://waterdata.usgs.gov/id/nwis.

Big Lost River Infiltration Studies

During high flows of the Big Lost River, large amounts of water recharge the SRPA through the channel bottom. Infiltration also occurs at the INEEL spreading areas and through the terminal playas of the Big Lost River. During the history of the INEEL, several studies to estimate the amount and the mechanisms of infiltration have been done. Extensive studies of Big Lost River infiltration were done during 1951–53 (Nace and others, 1959). The USGS INEEL Project Office annual reports provided summaries of studies to define infiltration in the various parts of the drainage basin. An example summary of infiltration in the main channel, the playas, and the spreading areas was provided by Barraclough, Teasdale, and Jensen (1967). In 1985, a study was conducted to estimate stream losses to infiltration in selected reaches of the Big Lost River. Stream losses at different discharges were measured in 1985, and then monthly stream losses were estimated for these reaches. The estimates were based on historical records of stream-discharge measurements for 1965–88. The results of this study were provided by Bennett (1990). Additional estimates of infiltration near the RWMC (based on studies of chlorine-36, tritium, and neutron-logging measurements in the unsaturated zone) were summarized by Cecil and others (1992).

Flood Hazard Studies, Big Lost River and Birch Creek

In 1965, the Big Lost River nearly topped the earth dam—the central feature of the flood-control system at the INEEL—as a result of snowmelt flooding. Concern that future floods could exceed the capacity of the flood-control system led to studies of potential effects of floods on the Big Lost River and Birch Creek. Carrigan (1972) studied the probability of floods exceeding the capacity of the flood-control system, and Druffel and others (1979) studied the probable hydrologic effects of a failure of Mackay Dam on the Big Lost River Valley from Mackay, Idaho, to the INEEL. Bennett (1986) determined the capacity of the diversion channel below the flood-control dam on the Big Lost River at the INEEL. Studies estimating or simulating 100-year peak flows and water-level elevations and/or water volumes were done during the 1990s. The results of these studies were presented by

Kjelstrom and Berenbrock (1996) for the Big Lost River and Birch Creek, by Berenbrock and Kjelstrom (1997) for Birch Creek, and by Berenbrock and Kjelstrom (1998) for the Big Lost River. Additional studies related to flood hazards at the INEEL include a study to determine the effects of traveltime and infiltration losses for tributary subbasins on the flood hydrology of the Big Lost River at Arco, and a study to determine the effects of bedrock configuration and scouring on reducing backwater during flood events.

Small Drainage-Basin Gaging Network

The amount of recharge from infiltration of rainfall, snowmelt, and streamflow has been assumed to be negligible except along the channel of the Big Lost River and INEEL spreading areas. To evaluate the validity of this assumption, a small drainage-basin gaging-station network was established during the 1980s. The network was designed for long-term data collection with a minimal amount of work effort; most gages were located in stream-channel reaches that could be rated theoretically. The network consisted of 3 drainage basins that range in size from 2 to 20 mi^2 and the basins were instrumented to measure runoff. The three basins are topographically closed and each contains a terminal playa that will store runoff and allow it to recharge the aquifer. Data from the small drainage-basin network are available from the USGS INEEL Project Office.

Unsaturated-Zone Program

RWMC Characterization Study

During the 1970s, a study was done to formulate a conceptual model of the hydrogeochemical environment of the shallow unsaturated zone at the INEEL and to determine how changes in that environment could affect the mobility and migration of waste radionuclides buried in the SDA of the RWMC. Data collected during that study and conclusions drawn from the data were reported by Rightmire (1984) and Rightmire and Lewis (1987a, 1987b).

Test-trench facility studies

In 1985, the USGS and DOE contractor constructed and instrumented the test-trench facility immediately north of the RWMC to describe the hydraulic and solute-transport characteristics of the unsaturated zone underlying the RWMC. The facility was operated by the USGS through 1999. A simulated-waste trench was installed in 1988 to define the movement of water in disturbed material. The installations were designed to provide information on the net downward flux of water through surficial material at the RWMC. The trenches were instrumented to collect information for calculation of hydraulic properties of the surficial material. Additionally, vertical neutron moisture-meter access holes were constructed to provide soil-moisture content data as a function of depth and position within the test-trench area. A micrometeorological station at the test-trench facility provided atmospheric precipitation data to compute evapotranspiration. Data collection at the facility has been completed and is available for interpretive research studies (Pittman, 1989; Davis and Pittman, 1990; Perkins and others, 1998; Perkins, 2000). During 1991–92, soil-core samples were collected at the test-trench facility to determine changes in hydraulic properties caused by the construction of the simulated-waste trench. The results are available in reports by Shakofsky (1995) and Nimmo and others (1999).

Hydraulic Properties of Sedimentary Interbeds Study

An investigation of hydraulic properties of the sedimentary interbeds within the basalts near the RWMC began in 1998. A major objective is to develop a practical and relatively inexpensive methodology for determining the hydraulic properties of the sedimentary interbeds. This study will help to explain the role of interbeds in contaminant transport, especially as related to lateral flow, preferential flow, and impedance of downward flow, perching, and retardation. Preliminary findings of this study were provided by Perkins and Nimmo (2000).

Large-Scale Tracer Test Studies

In 1999, a tracer study to determine long-range flowpaths through the unsaturated zone at the RWMC was done. A naphthalene sulfonate tracer, introduced into the INEEL spreading areas, later was detected in SRPA wells and in perched-water wells in the unsaturated zone (up to 1.3 km away from the point of introduction). These detections indicate that rapid vertical and horizontal transport of the tracer was taking place in the unsaturated zone (Nimmo and others, 2002).

Summary and Conclusions

This report is a summary of the historical development of the USGS hydrologic monitoring and investigative programs at the INEEL. The report covers the time period 1949–2001 and contains general information on the USGS's water-level monitoring program, water-quality sampling program, geophysical program, geologic framework program, drilling program, surface water program, and unsaturated-zone program. The report provides physical information about the wells and historical information about the frequencies of sampling and measurement. A summary of USGS published reports is provided in an appendix. This report was prepared in cooperation with the DOE and provides the basis for evaluating the current monitoring programs and networks and determining future directions of the investigative programs.

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Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
USGS 1	2N 31E 35dcc1	432700112470801		O
USGS 2	3N 32E 29ddc1	433320112432301	4333201124322	O
USGS 3	never completed			
USGS 3A	3N 33E 03aba1	433732112335401	well destroyed	well destroyed
USGS 4	5N 34E 09bda1	434657112282201	4346561122821	O
USGS 5	3N 30E 12cdd1	433543112493801		O
USGS 6	4N 31E 16adc1	434031112453701	4340311124535	O
USGS 7	6N 31E 27bdd1	434915112443901		O
USGS 8	2N 27E 02ddc1	433121113115801	4331211131157	O
USGS 9	2N 28E 35aac1	432740113044501		O
USGS 10	never completed			
USGS 11	1N 29E 30bbd1	432336113064201		O
USGS 12	4N 30E 07adb1	434126112550701		O
USGS 13 (Sunset Well, BLM)	2N 27E 33acc2	432731113143902		WL
USGS 14	1S 30E 15bca1	432019112563201	4320131125632	O
USGS 15	4N 30E 06aba1	434234112551701	4342351125517	O
USGS 16 (Packsaddle Well, BLM)	2S 30E 30bbb1	431333113001701	4313331130016	S
USGS 17	4N 30E 22bdd1	433937112515401		O
USGS 18	5N 31E 14bcc1	434540112440901		O
USGS 19	5N 29E 23cdd1	434426112575701		O
USGS 20	3N 30E 31aad1	433253112545901		O
USGS 21	5N 32E 36add1	434307112382601		WL
USGS 22	3N 29E 19cbb1	433422113031701	4334231130317	O
USGS 23	4N 29E 09dcd1	434055112595901		O
USGS 24	6N 31E 13dbb1	435053112420801		WL
USGS 25	7N 31E 34bdd1	435339112444601		WL
USGS 26	6N 32E 11aba1	435212112394001	4352131123940	O
USGS 27	6N 33E 26ddb1	434851112321801		O
USGS 28	5N 33E 17add1	434600112360101		WL
USGS 29	5N 34E 29daa1	434407112285101	4344071122850	O
USGS 30A	5N 33E 13bdc3	434601112315403	4346001123154	WL
USGS 30B	5N 33E 13bdc2	434601112315402		WL
USGS 30C	5N 33E 13bdc1	434601112315401		WL
USGS 31	5N 33E 10cdc1	434625112342101	4346261123421	O
USGS 32	5N 33E 23dda1	434444112322101		O
USGS 33	5N 33E 35daa1	434314112322901	well destroyed	well destroyed
USGS 34	3N 29E 25bdc1	433334112565501	4333341125654	O
USGS 35	3N 29E 25bdb1	433339112565801		O
USGS 36	3N 29E 25bdd1	433330112565201	4333301125651	O
USGS 37	3N 29E 25caa1	433326112564801	4333251125648	O
USGS 38	3N 29E 25cad1	433322112564301		O
USGS 39	3N 29E 25bbd1	433343112570001		O
USGS 40	3N 29E 24dad1	433411112561101		O
USGS 41	3N 29E 24dda1	433409112561301	4334081125612	O
USGS 42	3N 29E 24dda2	433404112561301	4334031125612	O
USGS 43	3N 29E 24dad2	433415112561501	4334151125614	O
USGS 44	3N 29E 24ddb1	433409112562101	4334081125621	O
USGS 45	3N 29E 24ddc1	433402112561801	4334021125617	O
USGS 46	3N 29E 24dda3	433407112561501	4334061125614	O

Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
USGS 47	3N 30E 19ccb1	433407112560301	4334061125602	O
USGS 48	3N 30E 19ccc1	433401112560301	4334011125602	O
USGS 49	3N 30E 19cca1	433403112555401	4334031125553	WL
USGS 50	3N 30E 19cbb1	433419112560201	4334191125601	O
USGS 51	3N 30E 30bbb1	433350112560601		O
USGS 52	3N 30E 19cac1	433414112554201		O
USGS 53	3N 29E 14dac1	433503112573401	4335021125734	O
USGS 54	3N 29E 14dac2	433503112572801	4335021125728	O
USGS 55	3N 29E 14dab1	433508112573001	4335081125729	O
USGS 56	3N 29E 14dab2	433509112573501		O
USGS 57	3N 29E 25abd1	433344112562601		O
USGS 58	3N 29E 14dda1	433500112572501		well deepened and renamed
	3N 29E 14dda2	433500112572502		O
USGS 59	3N 30E 30bab1	433354112554701		O
USGS 60	3N 29E 14dda3	433456112571901		O
USGS 61	3N 29E 13ccc1	433453112571601	4334531125715	O
USGS 62	3N 29E 24bba1	433446112570701	4334461125705	O
USGS 63	3N 29E 14dcd1	433455112574001		O
USGS 64	3N 29E 13cbb1	433513112571801	4335121125717	WL
USGS 65	3N 29E 23abb1	433447112574501		O
USGS 66	3N 29E 24bac1	433436112564801	4334391125657	O
USGS 67	3N 30E 30bad1	433344112554101	4333441125540	O
USGS 68	3N 29E 14acd2	433516112573901	4335151125739	O
USGS 69	3N 29E 14ddc1	433450112573001	4334501125729	O
USGS 70	3N 29E 13cbc1	433504112571001		O
USGS 71	3N 29E 24bbc1	433439112571501	4334401125715	O
USGS 72	3N 29E 14acc1	433519112574601		O
USGS 73	3N 29E 14dcb1	433502112575401	4335011125754	O
USGS 74	3N 29E 14cac1	433505112580501		O
USGS 75	3N 29E 13cdb1	433457112570001	4334561125659	WL
USGS 76	3N 29E 23adc1	433425112573201		O
USGS 77	3N 30E 30ccb1	433315112560301		O
USGS 78	3N 29E 23dac1	433413112573501		O
USGS 79	3N 29E 14cbd1	433505112581901		O
USGS 80	3N 29E 13cdb2	433457112570002		U
USGS 81	3N 30E 19ddc1	433400112551001		U
USGS 82	3N 30E 19ddc2	433401112551001	4334011125509	O
USGS 83	2N 29E 13aaa1	433023112561501		O
USGS 84	3N 29E 23dcd1	433356112574201	4333571125742	O
USGS 85	3N 29E 36bcb1	433246112571201	4332461125711	O
USGS 86	2N 28E 21bbb1	432935113080001		O
USGS 87	2N 29E 18bda1	433013113024201	4330131130241	O
USGS 88	2N 29E 18ccd1	432940113030201		O
USGS 89	2N 28E 13add1	433005113032801		O
USGS 90	2N 29E 17cbc1	432954113020501	4329541130204	O
USGS 91	backfilled			U
USGS 92	2N 29E 18bdc1	433000113025301		O
USGS 93	backfilled			O

Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
USGS 94	backfilled			U
USGS 95	backfilled			U
USGS 96	backfilled			U
USGS 97	4N 30E 31abd1	433807112551501	4338071125514	O
USGS 98	3N 29E 01dbb1	433657112563601		O
USGS 99	3N 30E 06acd1	433705112552101		O
USGS 100	3N 32E 14cdd1	433503112400701	4335031124006	O
USGS 101	3N 32E 36add1	433255112381801		O
USGS 102	4N 30E 30aca1	433853112551601		O
USGS 103	2N 30E 31cbc1	432714112560701		O
USGS 104	2N 29E 24dad1	432856112560801		O
USGS 105	2N 29E 33dcc1	432703113001801		O
USGS 106	2N 29E 15cba1	432959112593101		O
USGS 107	2N 30E 16cca1	432942112532801		O
USGS 108	2N 29E 35ccc1	432659112582601		O
USGS 109	2N 29E 31cdc1	432701113025601		O
USGS 110	2N 30E 35dad1	432717112501501	well destroyed	U
USGS 110A	2N 30E 35dad2	432717112501502		O
USGS 111	3N 30E 30bcc1	433331112560501		O
USGS 112	3N 29E 25dca1	433314112563001	4333151125631	O
USGS 113	3N 29E 25ddb1	433314112561801	4333151125618	O
USGS 114	3N 30E 30cbd1	433318112555001	4333191125551	O
USGS 115	3N 30E 30cad1	433320112554101		O
USGS 116	3N 30E 30acc1	433331112553201	4333321125533	O
USGS 117	2N 29E 18cbd1	432955113025901		O
USGS 118	2N 29E 18dca1	432947113023001		WL, GM
USGS 119	2N 29E 18dcb1	432945113023401		O
USGS 120	2N 29E 19bcb1	432919113031501		O
USGS 121	3N 30E 18ccc1	433450112560301		O
USGS 122	3N 30E 30bba2	433353112555201		WL
USGS 123	3N 29E 25aaa2	433352112561401		O
USGS 124	1N 30E 29ccb1	432307112583101		O
USGS 125	1N 29E 08bcd1	432602113052801		O
USGS 126A	7N31E20bdb1	435529112471301		O
USGS 126B	7N31E20bdb2	435529112471401		O
USGS 127	2N 29E 11add1	433058112572201		O
A11 A31	2N 29E 18add1	432853113021701		WL
ANL CH-1	3N 32E 14aac1	433545112394101		WL
ANL MW-11	3N 32E 13bcb1	433534112392901		WL
ANL MW-13	3N 32E 14aac2	433545112394102		WL
ANP-5	7N 31E 33dcd1	435308112454101		WL
ANP-6	6N 31E 10acc1	435152112443101		O
ANP-7	7N 31E 22bdd1	435522112444201	4355231124441	WL
ANP-9 (STFA 1)	6N 32E 26cdb1	434856112400001		O
ANP-10 (STFA 2)	6N 32E 26cab1	434909112400401		WL
ARA 2 (Area SL-1)	2N 30E 12abd1	433107112492201	4331061124921	FP
ARA 3 (GCRE)	2N 30E 01bdb1	433156112494401		FP
Arbor Test	3N 32E 13dca1	433509112384801		O
AREA II (NTP Area 2)	3N 31E 35dca1	433223112470201		O

Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
Atomic City Well	1N 31E 03cac1	432638112484101		PS
Cerro Grande	1N 30E 10bba1	432618112555501	4326181125554	WL
CFA 1 (Navy 1)	2N 29E 01aac1	433204112562001		FP
CFA 2 (Navy 2)	2N 29E 01dbb1	433144112563501		FP
CFA LF 2-8	3N 29E 36dcd1	433216112563201		CO
CFA LF 2-10	3N 29E 36dcc2	433216112563301		O
CFA LF 2-11	3N 29E 36dac1	433230112561701		WL
CFA LF 3-9	3N 29E 36ccc1	433216112571001		O
CFA LF 3-11	3N 29E 36bdb1	433249112565501		well destroyed
CFA LF 3-11A	3N 29E 36bdb2	433251112565601		not completed
Corehole 1	2N 32E 22aba1	432927112410101		WL
Corehole 2A	5N 31E 15bad1	434558112444801		WL
CPP 1	3N 30E 19bcb1	433433112560201		FP
CPP 2	3N 29E 24ada1	433432112560801		FP
CPP 3 (CPP Disp.)	3N 30E 19cbc1	433413112560401	4334131125605	cemented shut
CPP 4	3N 30E 19bac1	433440112554401		FP
CPP 5	3N 30E 19bac2	433440112554402		FP
CTF 1 (FET 1) (LOFT 1)	6N 31E 14abb1	435120112432101	4351201124320	FP
CTF 2 (FET 2) (LOFT 2)	6N 31E 14aba1	435119112431801	4351191124317	FP
CWP 1	3N 29E 14dda5	433459112572601		O
CWP 2	3N 29E 14dda6	433458112572401		O
CWP 3	3N 29E 14ddd1	433455112572501		O
CWP 4	3N 29E 14ddd2	433454112572601		O
CWP 5	3N 29E 14ddc1	433455112572901		O
CWP 6	3N 29E 14ddb1	433456112573301		O
CWP 7	3N 29E 14ddb2	433458112573201		O
CWP 8	3N 29E 14ddb3	433500112573001		O
CWP 9	3N 29E 14ddb4	433500112572901		WL
DH1B	5N 30E 11cdd1	434611112504301		WL
DH2A	5N 30E 15adc1	434547112512801		WL
EBR 1	2N 29E 09caa1	433051113002601		FP
EBR II-1	3N 32E 13bbd2	433546112391601	4335441123918	FP
EBR II-2	3N 32E 13bbd3	433544112391301	4335441123925	FP
EOCR	2N 30E 05ddd1	433120112535101	4331201125349	U
FET Disposal (FET 3)	6N 31E 11cdc1	435124112433701	4351241124336	WL
Fire Station 2	3N 29E 12ddb1	433548112562301		U
GIN 1	6N 31E 24dda1	434947112414301		WL
GIN 2	6N 32E 22ccb1	434949112413401		WL
GIN 3	6N 32E 22ccb2	434945112413101		WL
GIN 4	6N 32E 22ccb3	434949112413601		WL
GIN 5	6N 32E 22cbc1	434953112413301		WL
Highway 1 (piezo. C)	2N 35E 02bbc1	433218112191601		WL
Highway 1 (piezo. B)	2N 35E 02bbc2	433218112191602		WL
Highway 1 (piezo. A)	2N 35E 02bbc3	433218112191603		WL
Highway 2	3N 34E 32bbc1	433307112300001	4333091123000	WL
Highway 3	3N 29E 33bad1	433256113002501		PS
IET Disposal (ANP-4) (IET 1)	6N 31E 12acd1	435153112420501		O
INEL 1	3N 29E 01abb1	433717112563501		WL
Leo Rogers 1	1N 31E 08cdd1	432533112504901		S

Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
MTR Test	3N 29E 14add1	433520112572601		O
Main Gate Well (Badging Facility Well)	2N 30E 08dad1	433042112535101		FP
NA 89-1	2N 28E 13cba1	432956113041401		NA
NA 89-2	2N 28E 11adc1	433056113045101		NA
NA 89-3	2N 29E 19bcb2	432918113031701		NA
No Name 1 (TAN Exploratory Well)	6N 31E 16dca1	435038112453401		O
NPR Test	3N 30E 16ddd1	433449112523101		O
NPR WO-2	3N 30E 16ddd2	433451112523201		U
NRF 1 (STR 1)	4N 30E 30aad1	433859112545401	4338591125453	FP
NRF 2 (STR 2) S1W 2	4N 30E 30ada1	433854112545401		FP
NRF 3 (A1W)	4N 30E 30aad2	433858112545501		FP
NRF 4 (S5G 2)	4N 30E 30ada2	433853112545901		FP
NRF 5 (S5G 1)	4N 30E 30add1	433844112550201		U
NRF 6	4N 30E 19ddd1	433910112550101		O
NRF 7	4N 30E 20cca1	433920112543601		O
NRF 8	4N 30E 30adc1	433843112550901		O
NRF 9	4N 30E 30dab1	433840112550201		O
NRF 10	4N 30E 29cbb1	433841112545201		O
NRF 11	4N 30E 29bcd1	433847112544201		O
NRF 12	4N 30E 29bac1	433855112543201		O
NRF 13	4N 30E 19dad1	433928112545401		O
OMRE	2N 30E 08aaa1	433116112534701	4331171125346	U
2nd Owsley	6N 32E 36add1	434819112380501		WL
PBF 1 (Spert 1)	3N 30E 34bad1	433252112520301	4332531125203	FP
PBF 2 (Spert 2) (Spert IV Prod.)	3N 30E 34acb1	433247112515201	4332461125151	FP
PSTF Test	6N 31E 21dcc1	434941112454201		O
PW-1	3N 29E 25aaa1	433349112560701	4333491125608	O
PW-2	3N 30E 30bbd1	433344112555601	4333451125557	O
PW-3	3N 30E 30bba1	433351112555701	4333511125558	O
PW-4	3N 30E 30bac1	433348112554901	4333491125549	O
PW-5	3N 30E 30bbd2	433348112555701	4333491125557	O
PW-6	3N 29E 25aab1	433353112562201		O
PW-7	3N 29E 23abb2	433446112574602	4334471125747	O
PW-8	3N 29E 14dda4	433456112572001		O
PW-9	3N 29E 14cda1	433500112575401	4335011125755	O
P & W 1	7N 31E 28cac1	435416112460401	4354161124603	WL
P & W 2	7N 31E 28dab1	435419112453101		O
P & W 3	7N 31E 26bbc1	435443112435801		WL
Quaking Aspen Butte Well	1N 28E 03cdb1	432632113095901		S
Rifle Range Well	3N 29E 34bdd1	433243112591101	4332431125908	FP
RWMC M1SA	2N 29E 18cba1	432956113030901		O
RWMC M3S	2N 29E 18adb1	433008113021801		O
RWMC M4D	2N 29E 18ccd2	432939113030101		WL
RWMC M6S	2N 29E 20bba1	432931113015001		WL
RWMC M7S	2N 29E 17bba1	433023113014801		O
RWMC M10S	2N 29E 18cad1	432949113024301		well abandoned

Table 1. Well names, locations, and uses, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. Well No.: township, range, section. Latitude/longitude: blank spaces indicate latitude and longitude are the first 13 digits of the site ID No.. Well use: CO, contractor observation; FP, facility-water production; GM, gas monitoring; NA, neutron access; O, observation; PS, public supply; S, stock; U, unused; WL, water-level measurement;. **Abbreviations**: BLM, Bureau of Land Management; piezo., peizometer]

Well name	Well No.	Site ID No.	Latitude/Longitude	Well use
RWMC M11S	2N 29E 08adc1	433058113010401		O
RWMC M12S	2N 29E 03ccc1	433118112593401		O
RWMC M13S	2N 29E 09cda1	433037113002701		O
RWMC M14S	2N 29E 07daa1	433052113025001		O
RWMC Production	2N 29E 18adc1	433002113021701		FP
SB 01	3N 29E 14dbd4	433508112573801		CO
Site 4 (EFS Well) (Dairy Farm)	3N 30E 08bda1	433617112542001		FP
Site 6	4N 30E 26cca1	433826112510701	4338261125106	WL
Site 9	2N 30E 04dcc1	433123112530101		O
Site 14	5N 31E 28ccc1	434334112463101		O
Site 16	3N 32E 13bbd1	433545112391501	4335461123915	WL
Site 17	4N 29E 14caa1	434027112575701		O
Site 19	3N 29E 14bcb1	433522112582101		O
SWP 8	3N 30E 30bba6	433351112555401		O
SWP 13	3N 30E 30bbd3	433349112555702		O
TAN/TSF 1 (ANP-1)(TAN 1)	6N 31E 13acd1	435056112420001	4350571124159	CO
TAN TSF 2 (ANP-2)(TAN 2)	6N 31E 13acc1	435100112420701		CO
TAN/TSF Injection (ANP-3) (TAN Disp)	6N 31E 13cab1	435053112423201	4350531124231	CO
TAN 3	6N 31E 13aca1	435105112420301		CO
TAN 9	6N 31E 13cab3	435053112423202		CO
TAN 11	6N 31E 13cab6	435050112423202		CO
TAN Corehole 1 (TCH 1)	6N 31E 13bcd1	435058112423401		U
TAN Corehole 2 Piezo A (TCH 2)	6N 31E 13cdd3	435033112421701		WL
TAN Corehole 2 Piezo B (TCH 2)	6N 31E 13cdd4	435033112421702		WL
TAN Drainage Disposal 1 (TAN Runoff Drainage 1)	6N 31E 13dbc1	435042112420901		CO
TAN Drainage Disposal 2 (TAN Runoff Drainage 2)	6N 31E 13cab2	435054112423201		CO
TAN Drainage Disposal 3 (TAN Runoff Drainage 3)	6N 31E 14aab1	435116112430301		CO
TRA 1 (MTR 1)	3N 29E 14acd1	433521112573801		FP
TRA 2 (MTR 2)	3N 29E 14acb1	433523112575001	4335221125750	FP
TRA 3 (ETR 3)	3N 29E 14adb1	433522112573501	4335211125734	FP
TRA 4 (ATR 4)	3N 29E 14acd3	433521112574201		FP
TRA A-13	3N 29E 14dac3	433502112572802		O
TRA A-77	3N 29E 14dbd2	433507112573801		O
TRA Disposal	3N 29E 14dbd1	433506112572301	4335061125737	O
USBR Site 15	4N 35E 14aaa1	434102112180701		WL
Water Supply INEL 1	3N 29E 01abc1	433716112563601		O
Wheatgrass (BLM)	01S 30E 22dbd1	431907112560201		S
WRRTF Production (ANP-8) (LPT Prod.) (LPTF 1)	6N 32E 22cac1	434952112411301	4349511124113	FP
WWW 1 (VZ6A)	2N 28E 13add2	433004113033101		GM
4N 35E 20cca1	4N 35E 20cca1	433945112221701		WL
4N 35E 31daa1	4N 35E 31daa1	433759112225401		WL

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
USGS 1	12/1/49	636	6	-1.49	433	6	600	30	P
				423	636	5			
USGS 2	12/1/49	704	5	-1.9	434	6	675	21	P
				427	704	5			
USGS 3A	well destroyed with dynamite during seismic test								
USGS 4	1/—/50	553	6>322	-1.76	322	6	285	30	P
			8<322				322	231	O
USGS 5	3/16/50	500	6	-1.37	500	6	475	22	P
USGS 6	4/1/50	620	4>485	-1.84	404	6	452	23	P
			6<485	395	475	5	532	88	O
				-1.84	532	4			
USGS 7	4/4/50	1,200	4>760	-1	127	8	241	20	P
			6<760	-1.45	760	6	760	440	O
USGS 8	8/1/50	812	6	-1.61	812	6	782	30	P
USGS 9	12/10/51	654	8	-2.6	241	8	618	30	P
				235	654	6	652	2	P
USGS 10	never completed								
USGS 11	9/1/50	704	12	-2.11	704	6	673	31	P
USGS 12	6/26/50	563	10>387	-1.28	49	16	unk		
			12<387	-1.28	388	12			
				335	563	10			
USGS 13 (Sunset Well, BLM)	1951	1,200	6	0	33	10	998	202	O
				0	998	6			
USGS 14	3/—/51	752	6	-1.36	570	6	720	27	P
				560	752	5			
USGS 15	1951	610	10>480	-.96	540	10	unk		
			16<480	-.96	610	6			
USGS 16 (Packsaddle Well, BLM)	9/8/51	739	8	-1.9	336	8	704	30	P
				330	734	6			
USGS 17	8/1/51	498	6>406	-1.21	406	6	438	7	P
			8<406	365	496	5	496	2	O
USGS 18	9/—/51	329	4	0	255	6	298	24	P
				255	329	4			
USGS 19	9/24/51	399	6	-1.83	399	6	285	21	P
USGS 20	10/1/51	658	4	-1.73	404	8	471	10	P
				397	658	6	512	41	P
USGS 21	5/—/52	406	6	0	357	6	360	40	P
				351	404	5	404	2	O
USGS 22	11/26/51	657	6	-1.69	657	6	619	15	P
							644	15	P
USGS 23	3/27/52	463	6	-1.17	440	6	410	20	P
				430	463	5			
USGS 24	1952	326	8	0	326	8	255	10	P
							270	5	P
							285	40	P
USGS 25	1/1/52	320	6	0	320	6	285	35	S
USGS 26	10/—/52	267	8	-1.43	267	6	232	35	S
USGS 27	11/—/52	312	8	-2	312	6	250	10	P
							298	10	P

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
USGS 28	2/—/53	334	6	0	334	6	254	20	P
USGS 29	4/—/53	425	4>395	-2.3	398	6	363	62	O
			8<395						
USGS 30A	1969	725	3	0	722	1	717	2	P
USGS 30B	1969	398	8	0	397	0.75	392	5	P
USGS 30C	4/—/53	353	8	0	300	2	290	10	P
USGS 31	1953	428	8>306	-1.47	306	8	285	20	S
			10<306				306	22	O
USGS 32	1953	392	6>323	-3.4	324	6	306	86	O
			10<323						
USGS 33	well destroyed with dynamite during seismic test								
USGS 34	2/2/54	700	10>499	-0.42	499	10	499	201	O
			13<499						
USGS 35	8/—/55	578	7	-2	39	12	142	436	O
				-2	142				
USGS 36	9/13/55	567	6	-1.37	37	12	430	137	O
				-1.37	430	6			
USGS 37	10/13/55	572	6>507	-1.78	42	12	507	65	O
			8<507	-1.85	507	6			
USGS 38	10/—/55	729	6>505	0	26	12	678	51	O
			8<505	-1.44	505	6			
				475	678	4			
USGS 39	12/—/55	572	6>507	-1.4	48	12	47	525	O
			8<507						
USGS 40	7/—/56	483	6	-1	447	6	456	27	P
				432	483	4			
USGS 41	10/—/56	674	6	-2.74	428	6	428	46	O
USGS 42	2/—/57	678	6	-2.24	452	6	452	226	O
USGS 43	4/12/57	676	6	-2.07	451	6	451	225	O
USGS 44	7/—/57	650	6>461	-2	461	6	461	189	O
			8<461						
USGS 45	12/4/57	651	6>461	-1.9	462	6	462	189	O
			8<461						
USGS 46	1/—/58	651	6>461	-2	461	6	461	190	O
			8<461						
USGS 47	3/21/58	651	6	-1.5	458	6	458	193	O
USGS 48	5/16/58	750	6	-1.75	462	6	462	288	O
USGS 49	8/23/60	656	6	0	458	6	458	198	O
USGS 50	8/—/59	405	6	0	257	8	223	129	P
				230	357	6	357	48	O
USGS 51	1960	659	6	-1.95	475	6	475	184	O
USGS 52	9/21/60	650	6	0	50	16	450	200	O
				0	264	12			
				0	450	6			
USGS 53	2/—/60	75	6	0	44	6	44	31	O
USGS 54	3/—/60	91	6	0	60	6	60	31	O
USGS 55	3/—/60	81	6	-1.55	45	6	45	36	O
USGS 56	3/—/60	80	6	0	59	6	59	21	O
USGS 57	6/23/60	732	6	0	477	6	477	255	O

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
USGS 58	2/4/61	503	6	0	51	12	218	285	O
				0	101	8			
				0	218	6			
USGS 59	7/22/60	657	6	0	464	6	464	193	O
USGS 60	7/29/60	117	6	-1.9	59	6	59	58	O
USGS 61	8/25/60	123	8>117	0	67	6	89	34	P
			10<117	.5	123	4			
USGS 62	9/20/60	165	8>145						
			10<145	-1.7	145	6	145	20	O
USGS 63	10/18/60	109	6>97	0	62	6	62	47	O
			10<97						
USGS 64	10/26/60	205	6>186	0	186	6	186	19	O
			10<186						
USGS 65	12/—/60	498	6	0	456	6	456	42	O
USGS 66	11/21/60	378	4>355	0	220	6	160	40	P
			6<355	0	378	4			
USGS 67	12/2/60	694	6	0	465	6	465	87	P
				552	635	4	635	59	O
USGS 68	12/14/60	128	10	0	50	6	50	78	O
USGS 69	12/30/60	115	10	0	53	6	95	20	P
				0	115	4			
USGS 70	1/31/61	100	8	0	55	8	54	45	O
USGS 71	2/6/61	184	8	0	60	8	60	81	O
				141	184	5	155	29	P
USGS 72	2/13/61	175	6	0	37	8	172	28	O
				37	172	4	62	65	O
USGS 73	2/20/61	127	6	0	62	6	32	160	O
USGS 74	3/7/61	192	6	0	32	6	32	160	O
USGS 75	3/16/61	212	4	0	175	4	175	37	O
USGS 76	2/23/62	718	6	0	268	8	457	261	O
				0	457	6			
USGS 77	3/5/62	610	6	0	470	6	470	140	O
USGS 78	1962	204	7	0	66	12	66	138	O
USGS 79	5/3/62	702	6	0	281	6	281	421	O
USGS 80	4/17/62	204	4	0	43	4	43	161	O
USGS 81	1960	104	4	0	26	4	24	80	O
USGS 82	1962	700	8	0	460	8	470	50	P
				445	593	6	593	107	O
USGS 83	1962	752	6	-2.41	516	6	516	236	O
USGS 84	1962	505	6	0	324	6	324	181	O
USGS 85	8/9/62	637	6	0	522	6	522	115	O
USGS 86	10/—/66	691	8	0	48	8	48	643	O
USGS 87	9/7/71	640	6	0	585	6.5	585	55	O
USGS 88	9/15/71	635	6	0	587	6	587	48	O
USGS 89	2/1/72	646	6	0	576	6	576	70	O
USGS 90	3/18/72	626	6	0	580	6	580	46	O
USGS 91	backfilled								
USGS 92	6/16/72	214	6	0	19	6	19	195	O

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
USGS 93	backfilled								
USGS 94	backfilled								
USGS 95	backfilled								
USGS 96	backfilled								
USGS 97	7/7/73	510	4	0	45	8	388	122	O
				0	139	6			
				0	388	4			
USGS 98	7/9/73	505	6	0	62	8	401	20	P
				0	407	6	463	42	O
				401	505	4			
USGS 99	9/20/74	450	6	0	33	8	303	146	P
				0	344	6	449	1	O
				303	146	4			
USGS 100	9/19/74	750	6	0	15	8	663	83	O
				0	663	6			
USGS 101	9/1/74	865	6	0	29	8	750	115	P
				0	774	6			
				750	865	4			
USGS 102	8/8/89	445	6	0	21	10	360	85	O
				0	360	6			
USGS 103	8/20/80	760	8	0	10	12	575	185	O
				0	575	8			
USGS 104	7/30/80	700	8	0	10	12	550	150	O
				0	550	8			
USGS 105	9/9/80	800	8	0	10	12	400	400	O
				0	400	8			
USGS 106	8/28/80	760	8>605	0	10	12	400	360	O
			10<605	0	400	8			
USGS 107	9/2//80	690	8	0	10	12	270	420	O
				0	200	8			
				0	270	6			
USGS 108	9/11/80	760	8	0	12	12	400	360	O
				0	400	8			
USGS 109	9/13/80	800	6	0	10	16	600	200	P
				0	175	8			
				175	340	6			
				0	800	4			
USGS 110	9/20/80	780	6	0	5	12	580	200	P
				0	350	8			
				0	780	6			
USGS 110A	9/—/95	644	10	-2.6	657	6	240	417	P
USGS 111	8/31/84	595	8	0	10	10	442	153	O
				-2.04	442	8			
USGS 112	9/7/84	563	8	0	29	10	432	131	O
				-2.08	432	8			
USGS 113	9/12/84	564	6	0	15	10	445	119	O
				-2.12	445	6			
USGS 114	9/20/84	562	6	0	19	10	440	122	O
				-2.06	440	6			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
USGS 115	10/5/84	581	6	0	23	10	437	144	O
				-2.04	437	8			
USGS 116	10/5/84	580	6	0	38	8	400	180	O
				-2.32	400	6			
USGS 117	10/12/87	655	8	0	261	11	550	105	P
				-2	553	9			
				550	655	7			
USGS 118	10/23/87	610	4	-2	221	4	221	350	O
	10/00/92	608	4>570	-1	608	2	587	21	P
			6<570						
USGS 119	10/23/87	705	8	0	276	11	639	66	P
				-2	584	9			
				573	705	7			
USGS 120	11/10/87	705	8	0	294	11	638	67	P
				-2.0	587	9			
				574	705	7			
USGS 121	10/00/89	475	8	-1.5	39	12	449	26	R
				-2	433	8			
				413	449	6			
USGS 122	4/00/90	480	4	-2.2	30	12	449	26	R
				-1	276	8			
				-2	439	4			
				122	480	3			
USGS 123	11/00/89	481	8	-1.5	37	12	450	25	S
				-2	442	8			
				423	481	6			
USGS 124	7/20/93	800	6	0	18	10	750	50	P
				18	380	6			
				0	800	4			
USGS 125	8/20/94	774	10	0	16	10	620	154	P
				0	774	6			
USGS 126A	5/23/00	648	6>543	0	10	10	624	24	O
			10<543	0	540	6			
				0	624	5			
USGS 126B	5/22/00	452	6	0	10	10	407	45	O
				-1.5	407	6			
USGS 127	10/15/99	596	8	-1	13	10	496	102	L
				-1	123	8			
				-1.5	496	6			
A11 A31	11/18/93	675	8	-1.9	675	4	635	40	p
ANL CH-1	6/24/94	1,910	3>1,767						
			4>618	0	8	8			
			8>8	0	618	4	618	572	O
			10<8	1,190	1,734	3	1,734	176	O
ANL MW-11	10/7/91	654	8	0	19	12	614	35	R
				-2	609	8			
				589	614	6			
ANL MW-13	9/27/94	665	17.5<10	0	10	12	637	25	R
			12<630	0	627	8			
			9>630	617	637	6			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
ANP-5	5/8/56	396	10	0	396	10	296	20	P
							332	58	P
ANP-6	7/28/56	305	12	0	305	10	211	46	P
							266	30	P
ANP-7	5/12/56	433	8	0	433	8	354	77	P
ANP-9 (STFA 1)	6/—/56	322	12	-2.0	322	8	237	77	P
ANP-10 (STFA 2)	7/1/59	681	10	0	681	10	577	100	P
ARA 2 (Area SL-1)	3/23/57	787	22	-2	787	16	621	22.5	P
							664	42	P
							725	43	P
ARA 3 (GCRE)	3/18/59	1,340	2>978	0	756	14	978	362	O
			15<978	700	978	12			
			20<760						
Arbor Test	12/28/57	790	16	-2.1	790	10	680	50	P
AREA II (NTP Area 2)	1960	877	16	-2	776	10	676	47	P
							752	62	P
							854	22	P
Atomic City Well	5/—/52	639	8	-1.45	35	8	35	604	O
Cerro Grande	1/1/22	564	6	0	551	3			
				0	unk	6	551	16	O
CFA 1 (Navy 1)	7/—/43	639	16	0	444	16	444	195	O
CFA 2 (Navy 2)	5/1/44	681	20	6	68	20	521	130	P
				6	681	16	661	20	P
CFA LF 2-10	9/9/88	716	8>676	0	26	12	704	10	P
			12<676	0	676	8			
				0	755	6			
CFA LF 2-11	12/5/89	499	10	0	24	12	485	14	R
				0	30	10			
				0	485	4			
CFA LF 3-9	11/7/90	500	10	0	14	12	480	20	R
				0	480	4			
CFA LF 3-11	10/4/90	492	4	0	30	12	472	20	R
				0	472	4			
CFA LF 3-11A	not completed								
Corehole 1	8/5/78	2,000	3	0	2,000	3	991	10	P
							1,905	10	P
Corehole 2A	9/23/78	3,000		0	260	5	1,936	1,064	O
				0	400	4			
				0	1,936	3			
CPP 1	11/28/50	586	20	-0.8	586	16	460	25	P
							527	50	P
CPP 2	3/1/51	605	16	0.1	605	16	458	25	P
							551	49	P
CPP 3 (CPP Disp)	9/—50	598	24	-2.11	598	16	412	40	P
							490	103	P
CPP 4	10/—/83	700	16	0	50	24	450	150	P
				0	130	20			
				0	450	16			
				0	700	12			
CPP 5	1993	721	16	0	252	20	450	271	O
				252	450	16			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
CTF 1 (FET 1) (LOFT 1)	11/—/57	330	24	-1.5	330	18	230	100	P
CTF 2 (FET 2) (LOFT 2)	4/—/58	455	24>340	-1.5	455	18	209	239	P
			28<340						
CWP 1	1981	58	7	-2.8	58	6	20	38	P
CWP 2	1981	50	7	-2.5	50	6	20	30	P
CWP 3	1981	55	7	-3.1	55	6	20	35	P
CWP 4	1981	61	7	-2.6	61	6	20	41	P
CWP 5	1981	52	7	-3.1	52	6	20	32	P
CWP 6	1981	51	7	-3.9	51	6	20	31	P
CWP 7	1981	51	7	-2.9	51	6	20	31	P
CWP 8	1981	64	7	-3.1	64	6	20	44	P
CWP 9	1981	62	7	-3.1	62	6	20	42	P
DH1B	9/12/84	400	6	0	380	6	380	20	O
DH2A	9/24/84	430	6	0	415	6	415	15	O
EBR 1	7/14/49	1,075	10>750	-2.0	750	18	600	150	P
			22<750				750	325	O
EBR II-1	10/15/58	745	24	0	747	18	645	100	P
EBR II-2	5/7/59	753	20	-2	653	18	553	100	P
							653	100	O
EOCR	6/10/60	1237	16>1,052	-2	813	24	1,052	185	O
			20>848	706	848	20			
			24>813	762	1,052	16			
			28<813						
FET Disposal (FET 3)	9/11/57	300	10	0	300	10	175	120	P
Fire Station 2	9/26/57	516	16	-1.7	516	10	427	40	P
							501	10	P
GIN 1	2/7/64	373	8	0	48	8	48	325	O
GIN 2	3/26/64	402	8	0	43	8	43	359	O
GIN 3	3/2/64	386	8	0	38	8	40	90	P
				38	176	6	176	210	O
GIN 4	4/13/64	306	8	0	41	8	41	265	O
GIN 5	2/24/64	430	8	0	30	8	30	400	O
				0	30	4			
Highway 1	11/—/50	683	10	0	108	10	108	575	O
Highway 1 (piezo. C)	7/23/69	651	10	0	651	0.75	646	5	P
Highway 1 (piezo. B)	7/23/69	917	3	0	917	0.75	912	5	P
Highway 1 (piezo. A)	7/23/69	1120	3	0	1,120	0.75	1,115	5	P
Highway 2	8/29/50	786	8	0	786	8	741	45	P
Highway 3	9/15/67	750	8	-1.5	680	8	680	70	O
IET Disposal (ANP-4) (IET 1)	8/—/53	324	20	11	324	12	219	100	P
INEL 1	5/27/79	10,365	30	0	40	30	4,210	15	P
				0	1,511	20	4,240	30	P
				0	3,559	13	4,300	15	P
				3,282	6,796	9	4,490	30	P
							4,775	15	P
							5,085	15	P
							5,230	15	P
							5,995	15	P
							6,220	15	P
							6,260	15	P
							6,796	3,569	O

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
Leo Rogers 1	1966	720	20	0	20	20	20	700	O
MTR Test	11/16/49	588	8	-1.0	588	8	447	141	P
Main Gate Well	1/5/85	644	8	0	181	8	533	111	O
(Badging Facility Well)				0	553	6			
NA 89-1	6/—/89	232	4	-2.5	238	4	none		
NA 89-2	7/15/89	230	4	-2.4	235	4	none		
NA 89-3	8/4/89	180	4	-2.5	184	4	none		
No Name 1	11/27/63	550	12	-1.5	267	13	267	283	O
(TAN Exploratory Well)									
NPR Test	5/6/84	600	6	-2.0	599	6	500	35	P
NPR WO-2	9/23/91	5000	3>1,825	0	10	6	4,960	40	O
			4>615	0	1,825	4			
			6<615	0	4,960	3			
NRF 1 (STR 1)	8/1/50	535	16<483	0	483	18	394	84	P
			24>483	480	535	16	485	45	P
NRF 2 (STR 2) S1W 2	8/13/51	528	21	-0.9	528	16	373	24	P
							422	26	P
NRF 3 (A1W)	8/14/56	546	23<481	-2	481	24	485	58	P
			26>481	467	546	16			
NRF 4 (S5G 2)	unk	599	unk	unk	unk	unk	unk	unk	
NRF 5 (S5G 1)	1963	1,276	unk	unk	unk	unk	unk	unk	
NRF 6	8/8/91	417	8	0	10	13	359	58	R
				10	156	10			
				156	278	8			
				278	417	6			
NRF 7	8/7/91	417	10	0	25	14	365	50	R
				0	300	10			
				306	415	6			
NRF 8	6/20/95	423	8	0	25	12	373	50	R
				-3	315	8			
				290	373	6			
NRF 9	6/26/95	422	8	0	18	16	372	50	R
				-3	309	8			
				289	373	6			
NRF 10	7/7/95	427	8	0	20	16	377	50	R
				-3	298	8			
				279	377	6			
NRF 11	7/12/95	417	8	0	10	16	367	50	R
				-3	310	8			
				284	367	6			
NRF 12	7/17/95	421	8	0	31	16	375	50	R
				-3	320	8			
				297	375	6			
NRF 13	7/21/95	425	8	0	11	16	371	50	R
				-3	310	8			
				288	371	6			
OMRE	1/19/57	943	20	-0.2	681	14	535	91	P
				448	672	12	920	18	P
				670	828	10			
				800	940	8			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho—Continued.

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
2nd Owsley	1949	292	4	0	10	8	unk		
				10	309	4			
PBF 1 (Spert 1)	4/13/55	653	24	-2.7	653	14	482	10	P
							522	20	P
							552	30	P
							597	20	P
							632	20	P
PBF 2 (Spert 2) (Spert IV Prod.)	4/14/60	1,217	12>951	-1.9	767	16	950	267	O
			15>768	573	950	12			
			24<768						
PSTF Test	11/24/57	319	16	-2	320	10	190	126	P
PW-1	9/25/86	119	10	0	32	10	100	19	P
				-2	119	6			
PW-2	9/30/86	131	10	0	21	10	111	20	P
				-2	131	6			
PW-3	10/20/86	123	10	0	29	10	103	20	P
				-2	123	6			
PW-4	10/2/86	150	10	0	33	10	110	40	P
				-2	150	6			
PW-5	10/20/86	129	10	0	30	10	109	20	P
				-2	129	6			
PW-6	10/8/86	125	10	0	38	10	105	20	P
				-2	125	6			
PW-7	10/19/86	237	10	0	52	10	200	25	P
				-2	237	6			
PW-8	10/24/86	170	10	0	37	10	140	25	P
				-2	178	6			
PW-9	11/4/86	200	10	0	52	10	140	60	P
				-2	200	6			
P & W 1	5/15/57	432	10	0	432	10	322	50	P
P & W 2	6/25/57	386	10	0	386	10	313	70	P
P & W 3	8/13/57	406	10	0	406	10	322	79	P
Quaking Aspen Butte Well	2/12/82	1,115	8	0	19	8	1,036	38	P
				0	260	6			
				0	295	5			
				295	1,115	4			
Rifle Range Well	6/22/88	620	6	-1	150	8	600	20	P
				-1	310	6			
				305	625	5			
RWMC M1SA	7/16/92	638	12	-1.5	19	12	608	20	R
				-1.5	608	6			
RWMC M3S	7/10/92	633	12	0	20	18	603	30	R
				-1	254	12			
				-1	603	6			
RWMC M4D	8/20/92	828	12	0	20	18	798	30	R
				-.9	38.5	12			
				-1	798	6			
RWMC M6S	7/29/92	668	12	0	20	18	638	30	R
				-1	37	12			
				-1	638	6			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho.—Continued

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
RWMC M7S	8/19/92	628	12	0	16	18	598	30	R
				-1	30	12			
				-1	598	6			
RWMC M10S	7/30/92	648	12	0	20	18	618	30	R
				-1	39	12			
				-1	618	6			
RWMC M11S	7/14/98	624	10	-1.6	624	6	559	10	R
							604	20	R
RWMC M12S	7/9/98	572	10	-1	568	6	528	10	R
							548	20	R
RWMC M13S	7/14/98	643	10	-1	643	6	593	10	R
							623	20	R
RWMC M14S	7/14/98	645	10	-1	635	6	584	21	R
							625	10	R
RWMC Production	6/—/74	685	14	0	110	18	590	20	P
				0	562	14	625	10	P
				0	658	10	658	27	O
SB 01	8/24/90	43	10	-2.58	32.5	2	32.5	10	P
Site 4 (EFS Well) (Dairy Farm)	12/29/65	495	15	-2	495	8	416	75	P
Site 6	1956	523	15	0	523	10	366	98	P
Site 9	1960	1,057	10	-1.77	681	10.5	681	376	O
Site 14	8/30/56	717	8>377	-2	340	12	535	182	O
			10>340	320	535	10			
			12<340	313	535	8			
Site 16	1/23/57	758	15	-2	758	8	658	77	P
Site 17	1960	600	20	0	15	20	15	585	O
Site 19	9/19/60	865	10>576	-2	576	10	472	40	P
			18>576	0	865	8	532	40	P
							596	16	P
							780	82	P
SWP 8	1983	26	8	26	32	8	25	7	P
				0	32	2			
SWP 13	1983	32.5	8	-1.82	32.5	2	17.5	15	P
TAN/TSF 1 (ANP-1)(TAN 1)	1/26/53	360	16	0	360	16	200	155	P
TAN TSF 2 (ANP-2)(TAN 2)	8/29/53	340	24	-4.90	345	16	235	100	P
TAN/TSF Injection (ANP-3) (TAN Disposal)	6/8/53	310	12	0	310	12	180	64	P
							269	36	P
TAN 3	12/4/89	264	10	0	59	10	231	33	P
				0	264	4			
TAN 9	11/8/89	322	10	0	30	10	300	22	P
				0	322	4			
TAN 11	8/22/89	310	10	0	58	10	290	20	P
				0	310	4			
TAN Corehole 1 (TCH 1)	9/29/89	394	4	-2.28	46.3	4	389	5	R
				46.3	389	1.25			
TAN Corehole 2 Piezo. A (TCH 2)	12/19/90	497	4	-2.2	47	8	487	10	P
				-1.2	497	.75			
TAN Corehole 2 Piezo. B (TCH 2)	12/19/90	1090	4	-2.2	47	8	1,080	10	P
				-1.6	1,190	.75			

Table 2. Well completion and construction data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho.—Continued

[Well name: see figures 2-6 for locations. See table 4 for approximate water level below land surface. Units: Completion date: month/day/year. Well depth, in feet below land surface. Hole (that part below the water table) and casing diameter, in inches. Casing top and bottom, in feet below land surface. Openings, top, in feet below land surface; openings, length, in feet. Type: L, louvered, shuttered; O, open hole; P, perforated or slotted; R, wirewound; S, screen unknown. **Symbols**: negative sign indicates above land surface; >, deeper than; <, shallower than. **Abbreviations**: BLM, Bureau of Land Management; piezo., piezometer; unk, unknown]

Well name	Completion date	Well depth (ft)	Hole diameter (in.)	Casing (ft)			Openings		
				Top	Bottom	Diameter	Top (ft)	Length (ft)	Type
TAN Drainage Disposal 1	8/11/67	315	16	0	7	72	74	11	P
(TAN Runoff Drainage 1)				7	325	11	206	9	P
							285	30	P
TAN Drainage Disposal 2	8/2/67	252	16	0	7	72	117	10	P
(TAN Runoff Drainage 2)				7	262	11	201	20	P
							232	20	P
TAN Drainage Disposal 3	8/25/67	300	16	0	7	72	156	10	P
(TAN Runoff Drainage 3)							247	20	P
							277	23	P
TRA 1 (MTR 1)	3/21/50	600	20	-0.8	600	18	480	100	P
TRA 2 (MTR 2)	10/3/50	747	10>572	0	571	18	558	9	P
			24<572	558	572	12	572	29	O
				-2.05	746	8	645	9	P
TRA 3 (ETR 3)	3/17/57	602	20	-2.5	597	20	470	27	P
							518	74	P
TRA 4 (ATR 4)	7/25/63	965	18>765	0	50	26	900	65	P
			20<765	0	418	20			
				300	765	18			
				705	970	16			
TRA A-13	unk	59	2	-.92	59	1.5	49	10	O
TRA A-77	unk	34	2	-1.5	34	2	25	9	P
TRA Disposal	1963	1,267	8>1,150	25	43	18	515	555	P
			12>925	25	260	16	1,182	85	P
			14<925	25	425	14			
				-2.0	925	10			
				25	1,150	8			
				1,114	1,275	6			
USBR Site 15	7/29/69	1000	8>500	0	19	8	430	570	O
			3<500	0	430	6			
Water Supply for INEL 1	1/—/79	595	8	0	28	12	340	157	P
				0	314	10	507	88	O
				0	340	8			
				0	507	6			
Wheatgrass (BLM)	10/8/74	825	8	-2	825	6	815	10	P
WRRTF Production (ANP-8)	7/—/56	309	8	-2	309	8	233	72	P
(LPT Prod.) (LPTF 1)									
WWW1 (VZ6A)	unk	unk	unk	unk	unk	unk	unk		
4N 35E 20cca1	unk	577	unk	unk	unk	unk	unk		
4N 35E 31daa1	unk	731	unk	unk	unk	unk	unk		

Table 3. Pump installation data for monitoring wells, Idaho National Engineering and Environmental Laboratory, Idaho.

[Well name: see figures 2-6 for locations. **Units**: intake and measuring line depth, in feet below land surface; discharge pipe and measuring line diameter, in inches (in.); date installed, month/day/year; pumping rate, gallons per minute (gal/min). **Abbreviations**: HP, horsepower; sub., submersible; SS, stainless steel; galv., galvanized. Symbol ~, approximately equal to]

Well name	Pump type	Intake depth	Discharge pipe diameter and type	Date installed	Pumping rate (gal/min)	Measuring line		Remarks
						Diameter and type	Depth	
USGS 1	5 HP sub.	612	1 1/2 in. SS	7/3/90	19	1 in. steel	607	
USGS 2	5 HP sub.	683	1 1/2 in. SS	7/28/90	16	1 in. steel	677	
USGS 4	5 HP sub.	303	1 1/2 in. SS	7/31/90	40	1 in. steel	294	
USGS 5	5 HP sub.	488	1 1/2 in. SS	9/8/90	5	1 in. steel	483	
USGS 6	5 HP sub.	461	1 1/4 in. SS	9/5/90	25	3/4 in. steel	441	
USGS 7	5 HP sub.	242	1 1/2 in. SS	7/11/90	45	1 in. steel	229	
USGS 8	5 HP sub.	801	1 1/2 in. SS	7/10/90	16	1 in. steel	775	
USGS 9	5 HP sub.	635	1 1/2 in. galv.	7/30/87	19	1 in. galv.	625	
USGS 11	5 HP sub.	687	1 1/2 in. galv.	9/12/89	23	1 in. galv.	672	
USGS 12	5 HP sub.	358	1 1/2 in. SS	5/10/90	32	1 in. steel	351	
USGS 14	5 HP sub.	739	1 1/2 in. galv.	9/11/89	16	1 in. galv.	723	
USGS 15	5 HP sub.	358	1 1/2 in. SS	1/11/90	40	1 in. steel	352	
USGS 17	5 HP sub.	403	1 1/2 in. SS	9/8/89	32	1 in. galv.	390	
USGS 18	5 HP sub.	301.5	1 1/2 in. SS	8/29/90	30	1 in. steel	294	
USGS 19	5 HP sub.	322	1 1/2 in. SS	9/7/90	33	1 in. steel	315	
USGS 20	5 HP sub.	518	1 1/2 in. SS	9/7/90	30	1 in. steel	504	
USGS 22	5 HP sub.	643	1 1/2 in. SS	7/27/90	3	1 in. steel	630	
USGS 23	5 HP sub.	442	1 1/2 in. SS	8/29/90	25	1 in. steel	420	
USGS 26	5 HP sub.	255	1 1/2 in. SS	7/31/90	40	1 in. steel	231	
USGS 27	5 HP sub.	262	1 1/2 in. SS	8/28/90	20	1 in. steel	252	
USGS 29	5 HP sub.	402	1 1/2 in. SS	8/28/90	32	1 in. steel	378	
USGS 31	5 HP sub.	284	1 1/2 in. SS	8/24/90	40	1 in. steel	273	
USGS 32	5 HP sub.	322.4	1 1/2 in. SS	8/24/90	28	1 in. steel	315	
USGS 34	5 HP sub.	518	1 1/2 in. SS	8/14/90	30	1 in. steel	504	
USGS 35	5 HP sub.	523	1 1/2 in. SS	8/9/90	25	1 in. steel	504	
USGS 36	5 HP sub.	521	1 1/2 in. SS	8/14/90	25	1 in. steel	504	
USGS 37	5 HP sub.	506	1 1/2 in. SS	6/93	25	1 in. steel	494	
USGS 38	1.5 HP sub.	522	1 1/2 in. SS	9/26/90	4	1 in. steel	504	
USGS 39	5 HP sub.	485	1 1/2 in. SS	8/9/90	25	1 in. steel	483	
USGS 40	1.5 HP	462	1 in. galv.	7/80	8	1 in. galv.	465	
	1.5 HP sub.	467	1 in. galv.	8/15/90				
	10S15-21	480	1 in. galv.	11/17/92			476	
USGS 41	5 HP sub.	502	1 in. galv.	8/15/90	25	1 in. steel	483	
USGS 42	5 HP sub.	502.5	1 1/2 in. SS	8/15/90	25	1 in. steel	483	
USGS 43	1.5 HP sub.	509	1 in. galv.	7/80	6	1 in. steel		
USGS 44	5 HP sub.	499	1 1/2 in. SS	7/2/90	25	1 in. steel	483	
USGS 45	5 HP sub.	502	1 1/2 in. SS	7/26/90	25	1 in. steel	483	
USGS 46	5 HP	502	1 1/2 in. SS	7/26/90	25	1 in. steel	483	
USGS 47	1.5 HP	486	1 in. galv.	10/75-10/83	8	none		
	5 HP	486		8/86				
USGS 48	5 HP	503.5	1 1/2 in. SS	4/30/98	29	1 in. steel	483	new motor installed 4/30/98
USGS 50	1.5 HP	393	1 in. SS	12/94	.5	none		
USGS 51	1.5 HP	490	1 in. galv.	12/94	4	1 in. PVC	480	
USGS 52	5 HP	502	1 1/2 in. SS	6/24/87	30	1 in. steel	183	
USGS 53	Redi-Flo2	75	1/2 in. SS	8/8/90	~3	3/4 in. steel	75	pump pulled in1997 after hole dried up
USGS 54	Redi-Flo2	79	1/2 in. SS	10/12/93	4	3/4 in. steel	79	
USGS 55	Redi-Flo2	80	1/2 in. SS	9/23/93	1	3/4 in. steel	79	

Table 3. Pump installation data for monitoring wells, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. **Units**: intake and measuring line depth, in feet below land surface; discharge pipe and measuring line diameter, in inches (in.); date installed, month/day/year; pumping rate, gallons per minute (gal/min). **Abbreviations**: HP, horsepower; sub., submersible; SS, stainless steel; galv., galvanized. Symbol ~, approximately equal to]

Well name	Pump type	Intake depth	Discharge pipe diameter and type	Date installed	Pumping rate (gal/min)	Measuring line		Remarks
						Diameter and type	Depth	
USGS 56	Redi-Flo2	75	1/2 in. SS	9/28/93	1	3/4 in. steel	73	
USGS 57	1.5 HP	505	1 in. galv.	6/23/87	5	1 in. PVC	480	
	5 HP sub.	514	1 1/2 in. SS	1/91	30	1 in. steel	483	
USGS 58	5 HP	476	1 1/2 in. galv.	1/16/86	26	1 in. PVC	480	
USGS 59	1.5 HP	490	1 in. galv.	6/24/87	1	1 in. PVC	480	
USGS 60	Redi-Flo 2	94	1/2 in. SS	6/15/92	6	3/4 in. steel	84	
USGS 61	Redi-Flo 2	110	1/2 in. SS	6/16/92	6	3/4 in. steel	105	
USGS 62	Redi-Flo 2	152	1/2 in. SS	6/17/92	5	3/4 in. steel	147	
USGS 63	Redi-Flo 2	105	1/2 in. SS	6/16/92	5	3/4 in. steel	103	
USGS 65	1.5 HP sub.	490	1 in galv.	10/5/77	8	1 in. steel		
USGS 67	1.5 HP sub.	509	1 in. galv.	7/80	8	none		
	1.5 HP sub.	458	1 in. SS	10/86		none		
		506		2/95	8			
USGS 68	Redi-Flo 2	105	1/2 in. SS	6/16/92	~1	3/4 in. steel	84	
USGS 69	Redi-Flo 2	110	1/2 in. SS	6/16/92	5	3/4 in. steel	105	
USGS 70	Redi-Flo 2	97	1/2 in. SS	6/17/92	6	3/4 in. steel	94	
USGS 71	Redi-Flo 2	170	1/2 in. SS	6/17/92	~1	3/4 in. steel	168	pump pulled in 1999; currently open hole
USGS 72	Redi-Flo 2	168	1/2 in. SS	9/23/93	1	3/4 in. steel	157	
USGS 76	5 HP sub.	502	1 1/2 in. galv.	1/17/86	29	1 in. PVC	480	
USGS 77	5 HP sub.	502	1 1/2 in. SS	7/26/90	25	1 in. steel	483	
USGS 79	5 HP sub.	522	1 1/2 in. SS	8/23/90	30	1 in. steel	504	
USGS 82	1.5 HP sub.	510	1 in. galv.	6/25/87	6	1 in. PVC	490	
	5 HP sub.	508	1 1/2 in. galv.	6/93	25	1 in. steel	494	
USGS 83	1.5 HP sub.	606	1 in. galv.	8/80	6	1 1/2 in. steel		
	5 HP sub.	606	1 1/2 in. SS	3/96	25			
USGS 84	1.5 HP sub.	498	1 in. galv.	7/29/92	5	3/4 in. steel	494	
USGS 85	5 HP sub.	514	1 1/2 in. SS	8/23/90	23	1 in. steel	504	
USGS 86	5 HP sub.	678	1 1/2 in. galv.	8/3/87	19	1 in. galv.	665	
USGS 87	1.5 HP sub.	610	1 in. galv.	10/74	2	2 in. steel		
USGS 88	1.5 HP Pacific	634	1 in. galv.	10/74	3	none		
	1.5 HP Pacific		1 in. galv.	7/17/90	3	1 in. steel		pump removed 6/93
	Hydrostar		1 in. SS	7/17/90	1.5			
	1.5 HP sub.		1 in. galv.	6/22/93	2		625	
USGS 89	1.5 HP	620	1 in. galv.	7/75	5	2 in. steel	614	
		620	1 in. SS	6/28/93	5	1 in. steel		
USGS 90	1.5 HP sub.	607	1 in. galv.	10/74	4	2 in. steel	581	pump stuck in hole in 1999
	1.5 HP sub.	608	1 in. SS	9/13/93	4	1 in. steel	588	
USGS 97	5 HP sub.	402	1 1/2 in. galv.	1/22/86	27	3/4 in. steel	390	
USGS 98	5 HP sub.	423	1 1/2 in. galv.	1/21/86	25	1 in. PVC	420	
USGS 99	5 HP sub.	427	1 1/2 in. galv.	1/23/86	25	1 in. PVC	401	
USGS 100	5 HP sub.	696	1 1/2 in. galv.	1/28/86	10	3/4 in. steel	693	
USGS 101	5 HP sub.	790	1 1/2 in. galv.	1/29/86	13	1 in. PVC		
USGS 102	5 HP sub.	421	1 1/2 in. SS.	5/9/90	29	1 in. steel	399	
USGS 103	1.5 HP sub.	700	1 in. galv.	11/86	3			
	5 HP sub.	700	1 1/2 in. galv.	6/19/87	21	1 in. steel	600	
USGS 104	5 HP sub.	592	1 1/2 in. galv.	1/27/86	26		580	
USGS 105	1. 5 HP sub.	700	1 in. galv.	11.83	3	1 in. steel	680	
	5 HP sub.	700	1 1/2 in. galv.	6/22/87	24			
USGS 106	5 HP sub.	609	1 1/2 in. galv.	2/19/96	24	1 in. steel		

Table 3. Pump installation data for monitoring wells, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. **Units**: intake and measuring line depth, in feet below land surface; discharge pipe and measuring line diameter, in inches (in.); date installed, month/day/year; pumping rate, gallons per minute (gal/min). **Abbreviations**: HP, horsepower; sub., submersible; SS, stainless steel; galv., galvanized. Symbol ~, approximately equal to]

Well name	Pump type	Intake depth	Discharge pipe diameter and type	Date installed	Pumping rate (gal/min)	Measuring line		Remarks
						Diameter and type	Depth	
USGS 107	1.5 HP sub.	509	1 in. galv.	11/21/83	5	3/4 in. steel	512	
	5 HP sub.	531	1 1/2 in. SS.	6/11/92	3			
USGS 108	1.5 HP sub.	637	1 in. galv.	11/83	3	1 in. steel	630	
	5 HP sub.	637	1 1/2 in. galv.	6/87	24			
USGS 109	5 HP sub.	656	1 1/2 in. galv.	7/30/87	22	1 in. galv.	640	
USGS 110	1.5 HP sub.	612	1 in. galv.	11/83	6	1 in. galv.	606	well destroyed 6/92
USGS 110A	5 HP sub.	612	1 1/2 in. galv.	10/24/95	24	1 in. steel	606	
USGS 111	5 HP sub.	509	1 1/2 in. galv.	1/22/85	15	1 in. steel	502	
USGS 112	5 HP sub.	508	1 1/2 in. galv.	1/26/85	30	1 in. PVC	500	
				6/93		1 in. steel	494	
USGS 113	5 HP sub.	508	1 1/2 in. galv.	1/25/52	25	1 in. PVC	500	
				6/93		1 in. steel	494	
USGS 114	5 HP sub.	508	1 1/2 in. galv.	1/24/85	10	1 in. PVC	500	
				6/93		1 in. steel	494	
USGS 115	5 HP sub.	509	1 1/2 in. galv.	1/23/85	15	1 in. PVC	500	
	1.5 HP sub.	507	1 in. galv.	6/93	5	1 in. galv.	493	
USGS 116	5 HP sub.	508	1 1/2 in. galv.	1/30/85	20	1 in. PVC	500	
USGS 117	5 HP sub.	635	1 1/2 in. SS	10/13/87	5	none		pump removed 6/93
	Hydrostar	625	1 in. SS	7/6/90	1.5	none		
	5 HP sub.	635	1 in. SS	6/93	12	1 in. steel		pump removed 6/93
USGS 119	5 HP sub.	685	1 1/2 in. SS	10/24/87	3	1 in. galv.		
USGS 120	5 HP sub.	675	1 1/2 in. SS	11/12./87	27			
	Hydrostar	665	1 in. SS	7/12/90	1.5	none		pump removed 6/93
USGS 121	1.5 HP sub.				8			
USGS 122	3/4 HP sub	472	3/4 in. SS	4/94	~1	3/4 in. SS	468	pump quit (4/96); new pump installed 11/5/96, could not get water to surface
USGS 123	1.5 HP sub.	470	3/4 in. SS	4/5/94	3	1 in. steel	465	
USGS 124	5 HP sub.	737	1 1/4 in. SS	4/94	19	3/4 in. SS	693	
USGS 125	5 HP sub.	700	1 1/2 in. SS	4/26/95	21	3/4 in. steel	680	
USGS 126A	5 HP sub.	609	1 in. galv.	10/25/00	25	1 in. steel	420	
USGS 126B	5 HP sub.		1 in. galv.	11/21/00	25	1 in. steel	420	
USGS 127	5 HP sub.	546	1 12 in. SS	9/12/00	25	1 in. steel	525	
ANL MW-11	5 HP sub.	642	1 1/4 in. SS	2/92	17	1 in. steel	620	
ANP-6	5 HP sub.	237	1 1/2 in. galv.	1/10/86	45	1 in. PVC	240	
ANP-9 (STFA 1)	1.5 HP sub.	262	1 1/2 in. galv.	4/94	20	3/4 in. steel	252	
Arbor Test	5 HP sub.	720	1 1/2 in. galv.	10/88	20	1 in. steel	693	
Area II (NTP Area 2)	5 HP sub.	703	1 1/1 in. SS	8/7/90	18	1 in. steel	693	
CFA LF 2-10	5 HP sub.	547	1 1/2 in. galv.	6/26/91	~25	1 in. steel	523	pump removed 9/18/92
	2 HP sub.				8.3			
CFA LF 3-9	1.5 HP sub.	495	1 in. SS	7/94	7.5	3/4 in. steel	490	
IET Disposal (ANP-4)(IET 1)	5 HP sub.	233	1 1/2 in. galv.	1/13/86	46	1 in. PVC	240	
MTR Test	5 HP sub.	486	1 1/2 in. galv.	1/15/86	26	1 in. PVC	480	

Table 3. Pump installation data for monitoring wells, Idaho National Engineering and Environmental Laboratory, Idaho—Continued.

[Well name: see figures 2-6 for locations. **Units**: intake and measuring line depth, in feet below land surface; discharge pipe and measuring line diameter, in inches (in.); date installed, month/day/year; pumping rate, gallons per minute (gal/min). **Abbreviations**: HP, horsepower; sub., submersible; SS, stainless steel; galv., galvanized. Symbol ~, approximately equal to]

Well name	Pump type	Intake depth	Discharge pipe diameter and type	Date installed	Pumping rate (gal/min)	Measuring line		Remarks
						Diameter and type	Depth	
No Name 1 (TAN Exploratory well)	5 HP sub.	242	1 1/2 in. SS	7/31/90	42	1 in. steel	210	
NPR Test	5 HP sub.	486	1 1/2 in. galv.	1/23/86	28	1 in. steel	480	
NRF 6	5 HP sub	416	1 1/2 in. SS	9/3/91	30	1 in. steel	412	
NRF 7	5 HP sub.		1 1/2 in. SS	9/91	2.5	1 in. steel		
NRF 8	5 HP sub.	415	1 1/2 in. SS	7/95	30	1 in. steel		
NRF 9	5 HP sub.	412	1 1/2 in. SS	7/95	30	1 in. steel		
NRF 10	5 HP sub.	415	1 1/2 in. SS	7/95	30	1 in. steel		
NRF 11	5 HP sub.	409	1 1/2 in. SS	7/95	30	steel		
NRF 12	5 HP sub.	414	1 1/2 in. SS	7/95	30	steel		
NRF 13	5 HP sub.	405	1 1/2 in. SS	7/95	1	steel		
PSTF Test	5 HP sub.	242	1 1/2 in. SS	7/30/90	44	1 in. steel	231	
PW-1	Redi-Flo 2	110	1/2 in. SS		3			
PW-4	Redi-Flo 2	125	1/2 in. SS	6/15/92	6	3/4 in. steel	105	
PW-5	Redi-Flo 2	115	1/2 in. SS	9/28/93	8	3/4 in. steel	83	
PW-8	Redi-Flo 2	126	1/2 in. SS	6/15/92 10/17/96	8	3/4 in. steel	105	
PW-9	Redi-Flo 2	189	1/2 in. SS	6/15/92	5	3/4 in. steel	187	pump replaced in 1996
P & W 2	5 HP sub.	342	1 1/2 in. galv.	1/10/86	35	1 in. PVC	320	
Site 9	5 HP sub.	523	1 1/2 in. SS	8/31/90	25	1 in. steel	504	
Site 14	1.5 HP sub.	318	1 in. galv.	10/1/75	11	1 in. PVC	300	
	5 HP sub.	326	1 1/2 in. SS	6/12/92	40	1 in. steel	302	
Site 17	5 HP sub.	442	1 1/2 in. SS	9/6/90	26	1 in.steel	420	
Site 19	5 HP sub.	486	1 1/2 in. galv.	1/16/86	30	1 in PVC	480	
TAN/TSF Injection (ANP-3) (TAN Disposal)	5 HP sub.	234	1 1/2 in. galv.	1/14/86	20	1 in. PVC	240	well shut down
TRA Disposal	5 HP sub.	507	1 1/2 in. galv.	2/4/86	25	1 in. galv.	480	
Water Supply INEL 1	5 HP sub.	423	1 1/2 in. galv.	1/18/86	30	1 in. PVC	420	pump replaced in 1997

Table 4. U.S. Geological Survey field schedule showing wells and water-level frequency at and near the Idaho National Engineering and Environmental Laboratory, Idaho, 2000.

[Well name: see figures 2-6 for locations. Type: A, aquifer; P, perched water. **Abbreviations**: BM, well measured monthly for USGS Boise; S, water sample collected; AQ, aquifer well measured quarterly; AM, aquifer well measured monthly; R, well equipped with continuous water-level recorder; AS, aquifer well measured semi-annually; AA, aquifer well measured annually; PQ, perched well measured quarterly; PA, perched well measured annually; PM, perched well measured monthly. **Unit**: water level, in feet below land-surface datum]

Well name	Well type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Water level	Date
USGS 1	A	BM	BM	BM	S	BM	BM	BM	BM	BM	S	BM	BM	588.08	Dec-00
USGS 2	A	AQ			AQ			S			AQ			659.31	Oct-00
USGS 4	A	AQ			S			AQ			S			262.26	Oct-00
USGS 5	A	AQ			S			AQ			S			466.09	Oct-00
USGS 6	A	AQ			AQ			S			AQ			414.22	Oct-00
USGS 7	A	AQ			S			AQ			S			214.72	Oct-00
USGS 8	A	AQ			S			AQ			S			766.29	Oct-00
USGS 9	A	AM	AM	AM	S	AM	AM	AM	AM	AM	S	AM	AM	607.65	Dec-00
USGS 11	A	AQ			S			AQ			S			653.5	Oct-00
USGS 12	A	AM	S	AM	S	S	AM	AM	S	AM	S	S	AM	325.38	Dec-00
USGS 13	A				AA									986.49	Apr-00
USGS 14	A	AQ			S			AQ			S			716.34	Oct-00
USGS 15	A	AQ			AQ			S			AQ			315.62	Oct-00
USGS 17	A	AQ			S			AQ			S			351.98	Sep-00
USGS 18	A	AQ			AQ			S			AQ			272.34	Oct-00
USGS 19	A	AM	AM	AM	S	AM	AM	AM	AM	AM	S	AM	AM	274.34	Dec-00
USGS 20	A	AQ			S			AQ			S			460.84	Oct-00
USGS 21	A	R	R	R	R	R	R	R	R	R	R	R	R	333.14	Dec-00
USGS 22	A	AQ			AQ			S			AQ			610.04	Oct-00
USGS 23	A	AQ			S			AQ			S			396.18	Oct-00
USGS 24	A	R	R	R	R	R	R	R	R	R	R	R	R	217.71	Dec-00
USGS 25	A	R	R	R	R	R	R	R	R	R	R	R	R	270.5	Dec-00
USGS 26	A	AQ			S			AQ			S			211.92	Oct-00
USGS 27	A	AM	AM	AM	S	AM	AM	AM	AM	AM	S	AM	AM	226.44	Dec-00
USGS 28	A			AS						AS				234.36	Sep-00
USGS 29	A			AS				S						356.07	Jul-00
USGS 30A	A			AQ			AQ			AQ			AQ	257.77	Dec-00
USGS 30B	A			AQ			AQ			AQ			AQ	267.39	Dec-00
USGS 30C	A			AQ			AQ			AQ			AQ	269.18	Dec-00
USGS 31	A			AS				S						256.79	Jul-00
USGS 32	A			AS				S						290.79	Jul-00
USGS 34	A				S						S			471.32	Oct-00
USGS 35	A				S						S			472.26	Oct-00
USGS 36	A	S			S			S			S			471.92	Oct-00
USGS 37	A				S						S			471.44	Oct-00
USGS 38	A				S						S			471.92	Oct-00
USGS 39	A	S			S			S			S			473.77	Oct-00
USGS 40	A	S			S			S			S			457.82	Oct-00
USGS 41	A				S						S			458.22	Oct-00
USGS 42	A				S						S			458.79	Oct-00
USGS 43	A				S						S			457.59	Oct-00
USGS 44	A				S						S			459.3	Oct-00
USGS 45	A				S						S			460.48	Oct-00
USGS 46	A				S						S			458.08	Oct-00
USGS 47	A				S						S			456.62	Oct-00
USGS 48	A				S						S			459.58	Oct-00
USGS 49	A				AA									451.91	Apr-99
USGS 50	P	PQ			S			PQ			S			375.65	Oct-00
USGS 51	A				S						S			458.7	Oct-00
USGS 52	A				S						S			451.46	Oct-00
USGS 53	P	PQ			S			PQ			S			dry	Oct-00
USGS 54	P	S			S			S			S			75.55	Oct-00
USGS 55	P	PQ			S			PQ			S			dry	Oct-00
USGS 56	P	PQ			S			PQ			S			dry	Oct-00
USGS 57	A	S			S			S			S			465.25	Oct-00

Table 4. U.S. Geological Survey field schedule showing wells and water-level frequency at and near the Idaho National Engineering and Environmental Laboratory, Idaho, 2000—Continued.

[Well name: see figures 2-6 for locations. Type: A, aquifer; P, perched water. **Abbreviations**: BM, well measured monthly for USGS Boise; S, water sample collected; AQ, aquifer well measured quarterly; AM, aquifer well measured monthly; R, well equipped with continuous water-level recorder; AS, aquifer well measured semi-annually; AA, aquifer well measured annually; PQ, perched well measured quarterly; PA, perched well measured annually; PM, perched well measured monthly. **Unit**: water level, in feet below land-surface datum]

Well name	Well type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Water level	Date
USGS 58	A	AQ			S			AQ			S			459.62	Oct-00
USGS 59	A				S						S			454.71	Oct-00
USGS 60	P	PQ			S			PQ			S			79.81	Oct-00
USGS 61	P	PQ			S			PQ			S			99.11	Sep-00
USGS 62	P	PQ			S			PQ			S			136.96	Sep-00
USGS 63	P	PQ			S			PQ			S			88.91	Oct-00
USGS 64	P							PA						dry	Jul-00
USGS 65	A	S			S			S			S			465.06	Oct-00
USGS 66	P	PM	PM	PM	PM	PM	PM	S	PM	PM	PM	PM	PM	181.23	Dec-00
USGS 67	A				S						S			455.56	Oct-00
USGS 68	P	PQ			S			PQ			S			79.07	Oct-00
USGS 69	P	PQ			PQ			S			PQ			89.45	Oct-00
USGS 70	P	PQ			S			PQ			S			80.38	Oct-00
USGS 71	P	PQ			S			PQ			S			176.1	Oct-00
USGS 72	P	PQ			PQ			S			PQ			140.01	Oct-00
USGS 73	P	PQ			S			PQ			S			96.11	Oct-00
USGS 74	P	PQ			S			PQ			S			dry	Oct-00
USGS 75	P							PA						dry	Jul-00
USGS 76	A				S						S			472.46	Oct-00
USGS 77	A				S						S			464.62	Oct-00
USGS 78	P	R	R	R	R	R	R	S	R	R	R	R	R	170.81	Nov-00
USGS 79	A				S						S			472.72	Oct-00
USGS 82	A	S			S			S			S			448.51	Sep-00
USGS 83	A	AQ			S			AQ			S			497.99	Oct-99
USGS 84	A	AQ			S			AQ			S			480.64	Oct-00
USGS 85	A	AQ			S			AQ			S			482.16	Oct-00
USGS 86	A	AQ			S			AQ			S			649.13	Oct-00
USGS 87	A	S			S			S			S			589.37	Oct-00
USGS 88	A	S			S			S			S			592	Oct-00
USGS 89	A	S			S			S			S			602.36	Oct-00
USGS 90	A	S			S			S			S			580.47	Jun-99
USGS 92	P	PQ			S			PQ			S			211.99	Oct-00
USGS 97	A	AM	S	AM	S	S	AM	AM	S	AM	S	S	AM	377.92	Dec-00
USGS 98	A		S		S	S			S		S	S		405.3	Nov-00
USGS 99	A		S		S	S			S		S	S		391.94	Nov-00
USGS 100	A	AQ			S			AQ			S			676.83	Oct-00
USGS 101	A	AQ			S			AQ			S			770.25	Oct-00
USGS 102	A		S	AQ		S		S	S			S		368.68	Nov-00
USGS 103	A	S			S			S			S			583.48	Oct-00
USGS 104	A	S			S			S			S			556.11	Oct-00
USGS 105	A				S						S			669.9	Oct-00
USGS 106	A				S						S			587.9	Oct-00
USGS 107	A				S						S			479.87	Oct-00
USGS 108	A				S						S			608.69	Oct-00
USGS 109	A				S						S			620.92	Oct-00
USGS 110A	A				S						S			564.5	Oct-00
USGS 111	A				S						S			469.52	Oct-00
USGS 112	A	S			S			S			S			473.31	Oct-00
USGS 113	A	S			S			S			S			467.37	Oct-00
USGS 114	A	S			S			S			S			463.2	Oct-00
USGS 115	A	S			S			S			S			461.78	Oct-00
USGS 116	A	S			S			S			S			458.24	Oct-00
USGS 117	A	S			S			S			S			586.28	Oct-00
USGS 118	A			AQ			AQ			AQ			AQ	584.59	Dec-00
USGS 119	A	S			S			S			S			604.04	Oct-00

Table 4. U.S. Geological Survey field schedule showing wells and water-level frequency at and near the Idaho National Engineering and Environmental Laboratory, Idaho, 2000—Continued.

[Well name: see figures 2-6 for locations. Type: A, aquifer; P, perched water. **Abbreviations**: BM, well measured monthly for USGS Boise; S, water sample collected; AQ, aquifer well measured quarterly; AM, aquifer well measured monthly; R, well equipped with continuous water-level recorder; AS, aquifer well measured semi-annually; AA, aquifer well measured annually; PQ, perched well measured quarterly; PA, perched well measured annually; PM, perched well measured monthly. **Unit**: water level, in feet below land-surface datum]

Well name	Well type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Water level	Date
USGS 120	A	S	AM	AM	S	AM	AM	S	AM	AM	S	AM	AM	616.72	Dec-00
USGS 121	A				S						S			451.49	Nov-00
USGS 122	A			AS						AS				455.39	Sep-00
USGS 123	A				S						S			461.57	Sep-00
USGS 124	A				S						S			684.45	Oct-00
USGS 125	A	AQ			S			AQ			S			628.92	Oct-00
USGS 126A	A	S	AM	AM	S	AM	AM	S	AM	AM	S	AM	AM	410.74	Dec-00
USGS 126B	A	S	AM	AM	S	AM	AM	S	AM	AM	S	AM	AM	411.46	Dec-00
USGS 127	A	AM	AM	AM	S	AM	AM	AQ	AM	AM	S	AM	AM	507.94	Dec-00
A11 A31	A			AA										639	May-00
ANL CH-1	A			AA										635.56	May-00
ANL MW-13	A			AA										635.43	May-00
ANP-5	A				AA									292.25	Apr-00
ANP-6	A			AS				S						215.84	Jul-00
ANP-7	A				AA									351.67	Apr-00
ANP-9	A	AQ			S			AQ			S			224.52	Sep-00
ANP-10	A				AA									220.53	Apr-00
Arbor Test	A	AQ			S			AQ			S			680.01	Oct-00
Area II	A			AS				S						669.63	Jul-00
Cerro Grande	A			AQ			AQ			AQ			AQ	553.96	Dec-00
CFA LF 2-10	A	AQ			S			AQ			S			478.36	Oct-00
CFA LF 2-11	A				AA									470	Apr-00
CFA-LF 3-9	A			AS				S						482.44	Jul-99
Corehole 1	A		AQ			AQ			AQ			AQ			
Corehole 2A	A	AQ			AQ			AQ			AQ			211.78	Oct-00
CWP 1	P							S						47.92	Jul-00
CWP 2	P							S						45.51	Jul-00
CWP 3	P							S						dry	Jul-00
CWP 4	P							S						dry	Jul-00
CWP 5	P							S						dry	Jul-00
CWP 6	P							S						dry	Jul-00
CWP 7	P							S						dry	Jul-00
CWP 8	P							S						57.68	Jul-00
CWP 9	P							PA						31.27	Jul-00
DH1B	A	AQ			AQ			AQ			AQ			272.7	Oct-00
DH2A	A				AA									260.47	Apr-00
FET Disposal	A				AA									202.12	Apr-00
GIN 1	A				AA									210.45	Apr-00
GIN 2	A				AA									209.36	Apr-00
GIN 3	A				AA									209.39	Apr-00
GIN 4	A				AA									209.43	Apr-00
GIN 5	A				AA									209.47	Apr-00
Highway 1A	A			AQ			AQ			AQ			AQ	581.15	Dec-00
Highway 1B	A			AQ			AQ			AQ			AQ	582.12	Dec-00
Highway 1C	A			AQ			AQ			AQ			AQ	579.62	Dec-00
Highway 2	A			AQ			AQ			AQ			AQ	722.94	Dec-00
IET Disposal	A			AS				S						211.73	Jul-00
INEL 1	A				AA									308.59	Apr-00
Water Supply INEL 1	A				S						S			392.33	Oct-00
MTR Test	A	AM	AM	AM	S	AM	AM	AM	AM	AM	S	AM	AM	458.48	Dec-00
No Name 1	A				S						S			209.56	Sep-00
NPR Test	A	AQ			S			AQ			S			461.23	Oct-00
NRF 6	A		S	AQ		S			S			S		365.02	Nov-00
NRF 7	A		S			S			S			S		361.4	Nov-00
NRF 8	A		S			S			S			S		370.91	Nov-00

Table 4. U.S. Geological Survey field schedule showing wells and water-level frequency at and near the Idaho National Engineering and Environmental Laboratory, Idaho, 2000—Continued.

[Well name: see figures 2-6 for locations. Type: A, aquifer; P, perched water. **Abbreviations**: BM, well measured monthly for USGS Boise; S, water sample collected; AQ, aquifer well measured quarterly; AM, aquifer well measured monthly; R, well equipped with continuous water-level recorder; AS, aquifer well measured semi-annually; AA, aquifer well measured annually; PQ, perched well measured quarterly; PA, perched well measured annually; PM, perched well measured monthly. **Unit**: water level, in feet below land-surface datum]

Well name	Well type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Water level	Date
NRF 9	A		S			S			S			S		371.89	Nov-00
NRF 10	A		S			S			S			S		371.54	Nov-00
NRF 11	A		S			S			S			S		369.06	Nov-00
NRF 12	A		S			S			S			S		369.29	Nov-00
NRF 13	A		S			S			S			S		359.65	Nov-00
2nd Owsley	A				AA									223.21	Apr-00
P&W-1	A				AA									315.37	Apr-00
P&W-2	A				S						S			314.23	Oct-00
P&W-3	A				AA									304.13	Apr-00
PSTF Test	A				S						S			211.11	Sep-00
PW-1	P	S	R	R	S	R	R	S	R	R	S	R	R	dry	Dec-00
PW-2	P				S						S			122.01	Oct-00
PW-3	P				S						S			118.18	Oct-00
PW-4	P	S			S			S			S			67.64	Oct-00
PW-5	P				S						S			77.67	Oct-00
PW-6	P	S			S			S			S			dry	Oct-00
PW-7	P				S						S			dry	Oct-00
PW-8	P	S			S			S			S			80.73	Oct-00
PW-9	P	S			S			S			S			174.64	Sep-00
RWMC M1SA	A				AA									583.18	Apr-00
RWMC M3S	A			AS				S						587.13	Jul-00
RWMC M4D	A				AA									594.16	Apr-00
RWMC M6S	A				AA									637.75	Apr-00
RWMC M7S	A			AS				S						575.58	Jul-00
RWMC M11S	A				S						S			564.14	Oct-00
RWMC M12S	A				S						S			533.46	Oct-00
RWMC M13S	A				S						S			599.31	Oct-00
RWMC M14S	A				S						S			603.16	Oct-00
Site 6	A				AA									354.61	Apr-00
Site 9	A	AQ			AQ			S			AQ			472.68	Oct-00
Site 14	A	AQ			S			AQ			S			271.54	Oct-00
Site 16	A				AA									635.52	Apr-00
Site 17	A			AS				S						391.65	Jul-00
Site 19	A			AS				S						466.89	Jul-00
SWP 8	P							S						19.72	Jul-00
SWP 13	P							S						dry	Jul-00
TAN Corehole 2 Piezo. A	A	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	213.13	Dec-00
TAN Corehole 2 Piezo. B	A	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	AM	215.13	Dec-00
TRA Disposal	A				S						S			464.58	Oct-00
TRA A-13	P	PQ			S			PQ			S			dry	Sep-00
TRA A-77	P	PQ			S			PQ			S			dry	Oct-00
USBR Site 15	A			AA										412.21	May-00
4N 35E 20cca1	A				AA									505.64	Apr-00
4N 35E 31daa1	A				AA									606.49	Apr-00

Table 5. U.S. Geological Survey field schedule showing well and pump installation and sampling schedules for selected wells and stream-flow sites, 2000.

[Local site identifier: see figures 1-6 for location of sites. **Abbreviation**: gpm, gallons per minute, pumping rates are approximate; BLR, Big Lost River]

Local site identifier	Method of sampling	Analysis type (see code at back of table)			
		Jan	Apr	Jul	Oct
ANP-6	Pump 45 gpm			14	
ANP-9	Pump 20 gpm		34		35
Arbor Test	Pump 20 gpm		2		2
AREA II	Pump 18 gpm			14	
Atomic City Well*	Spigot		1		9
BLR (near Mackay)	Surface water		4		4
BLR (near Arco)	Surface water		4		4
BLR (INEL Diversion)*	Surface water		4		4
BLR (Dairy Farm)*	Surface water		4		4
Birch Creek*	Surface water		1		1
CFA 1*	Pump 1,000 gpm	11	13	11	14
CFA 2*	Pump 1,400 gpm	11	13	11	14
CFA LF 2-10	Pump 8.3 gpm		26		27
CFA LF 3-9	Pump 7.5 gpm			23	
CFA LF 3-11	Pump 7 gpm			23	
CPP 1	Pump 3,000 gpm		28		29
CPP 2	Pump 3,000 gpm		17		43
CPP 4	Pump 400 gpm		17		43
CPP 5	Pump 200 gpm		17		43
CWP 1	Bail @65 feet			6	
CWP 2	Bail @52 feet			6	
CWP 3	Bail @60 feet			6	
CWP 4	Bail @60 feet			6	
CWP 5	Bail @53 feet			6	
CWP 6	Bail @52 feet			6	
CWP 7	Bail @53 feet			6	
CWP 8	Bail @65 feet			6	
EBR 1	Pump 25 gpm		24		38
Highway 3*	Spigot		24		38
IET Disposal	Pump 46 gpm			14	
Leo Rogers 1	Pump 20 gpm			15	
Little Lost River	Surface water		1		1
Main Gate Well	Pump 35 gpm			14	
MTR Test	Pump 26 gpm		11		12
Mud Lake*	Surface		1		1
NPR Test	Pump 28 gpm		24		38
No Name 1 (Tan Expl.)	Pump 42 gpm		34		35
NRF 6***	Pump 30 gpm				
NRF 7***	Pump 2.5 gpm#				
NRF 8***	Pump 30 gpm				
NRF9***	Pump 30 gpm				
NRF10***	Pump 30 gpm				
NRF11***	Pump 30 gpm				
NRF12***	Pump 30 gpm				
NRF13***	Pump 1 gpm#				
PBF 1 (SPERT 1)	Pump 400 gpm			10	
PSTF Test	Pump 44 gpm		34		35
PW-1	Pump 3 gpm	3	5	3	13
PW-2	Bail @ 115 feet		5		13
PW-3	Bail @121 feet		5		13
PW-4	Pump 6 gpm	3	5	3	13
PW-5	Pump 8 gpm		5		13
PW-6	Bail @125 feet	3	5	3	13
PW-7	Bail @220 feet		7		17

Table 5. U.S. Geological Survey field schedule showing well and pump installation and sampling schedules for selected wells and stream-flow sites, 2000—Continued.

[Local site identifier: see figures 1-6 for location of sites. **Abbreviation**: gpm, gallons per minute, pumping rates are approximate; BLR, Big Lost River]

Local site identifier	Method of sampling	Analysis type (see code at back of table)			
		Jan	Apr	Jul	Oct
PW-8	Pump 8 gpm	6	7	6	17
PW-9	Pump 5 gpm	6	7	6	17
P&W2*	Pump 35 gpm		24		25
RWMC M1SA	Pump 3.4 gpm	44	44	44	44
RWMC M3S	Pump 3.7 gpm			23	
RWMC M7S	Pump 4.1 gpm			23	
RWMC M11S	Pump 6 gpm		24		25
RWMC M12S	Pump 6 gpm		24		25
RWMC M13S	Pump 6 gpm		24		25
RWMC M14S	Pump 6 gpm		24		25
RWMC Production**	Pump 200 gpm	39	21	39	22
Site 4	Pump 500 gpm		2		11
Site 9	Pump 25 gpm			14	
Site 14*	Pump 40 gpm		24		25
Site 17	Pump 25 gpm			14	
Site 19	Pump 30 gpm			11	
SWP 8	Bail from bottom of well			16	
SWP 13	Bail from bottom of well			16	
TRA 1	Pump 3,400 gpm			11	
TRA 3	Pump 3,800 gpm			11	
TRA 4	Pump 2,000 gpm			11	
TRA A-13	Bail from bottom of well		7		18
TRA A-77	Bail from bottom of well		7		18
TRA Disposal	Pump 25 gpm		7		19
Water Supply INEL 1	Pump 30 gpm		2		11
USGS 1	Pump 19 gpm		24		25
USGS 2	Pump 16 gpm			14	
USGS 4	Pump 40 gpm		24		25
USGS 5	Pump 5 gpm#		24		38
USGS 6	Pump 25 gpm			14	
USGS 7	Pump 45 gpm		34		35
USGS 8*	Pump 16 gpm		24		25
USGS 9	Pump 19 gpm		24		25
USGS 11*	Pump 23 gpm		24		25
USGS 12***	Pump 32 gpm		30		31
USGS 14*	Pump 16 gpm		4		4
USGS 15	Pump 40 gpm			14	
USGS 17	Pump 32 gpm		24		25
USGS 18	Pump 30 gpm			14	
USGS 19*	Pump 33 gpm		24		25
USGS 20	Pump 30 gpm		3		14
USGS 22	Pump 2.5 gpm#			9	
USGS 23	Pump 25 gpm		24		25
USGS 26	Pump 40 gpm		34		35
USGS 27*	Pump 20 gpm#		24		25
USGS 29	Pump 32 gpm			14	
USGS 31	Pump 40 gpm			14	
USGS 32	Pump 28 gpm			14	
USGS 34	Pump 30 gpm		28		29
USGS 35	Pump 25 gpm		3		14
USGS 36	Pump 25 gpm	3	3	3	14
USGS 37	Pump 25 gpm		3		20
USGS 38	Pump 4 gpm#		28		29

Table 5. U.S. Geological Survey field schedule showing well and pump installation and sampling schedules for selected wells and stream-flow sites, 2000—Continued.

[Local site identifier: see figures 1-6 for location of sites. **Abbreviation**: gpm, gallons per minute, pumping rates are approximate; BLR, Big Lost River]

Local site identifier	Method of sampling	Analysis type (see code at back of table)			
		Jan	Apr	Jul	Oct
USGS 39	Pump 25 gpm	3	3	3	14
USGS 40	Pump 8 gpm	8	8	8	20
USGS 41	Pump 25 gpm		3		14
USGS 42	Pump 25 gpm		3		14
USGS 43	Pump 6 gpm		5		20
USGS 44	Pump 25 gpm		5		16
USGS 45	Pump 25 gpm		3		14
USGS 46	Pump 25 gpm		5		16
USGS 47	Pump 8 gpm		5		20
USGS 48	Pump 29 gpm		3		14
USGS 50	Pump 0.5 gpm#		5		16
USGS 51	Pump 4 gpm		3		14
USGS 52	Pump 30 gpm		3		14
USGS 53	Bail from bottom of well		7		18
USGS 54	Pump 4 gpm	6	7	6	18
USGS 55	Pump 1 gpm		7		17
USGS 56	Pump 1 gpm		7		18
USGS 57	Pump 30 gpm	3	3	3	16
USGS 58	Pump 26 gpm		7		18
USGS 59	Pump 1 gpm		3		14
USGS 60	Pump 6 gpm		7		17
USGS 61	Pump 6 gpm		7		17
USGS 62	Pump 5 gpm		7		17
USGS 63	Pump 5 gpm		7		17
USGS 65*	Pump 8 gpm	7	36	7	37
USGS 66	Bail @ 214 feet			17	
USGS 67	Pump 8 gpm		3		14
USGS 68	Pump 1 gpm#		45		46
USGS 69	Pump 5 gpm			17	
USGS 70	Pump 6 gpm		7		17
USGS 71	Bail @ 175 feet		7		17
USGS 72	Pump 1 gpm			46	
USGS 73	Grundfos @100 feet; 1.5 gpm		7		17
USGS 74	Bail @ 190 feet		7		17
USGS 76	Pump 29 gpm		7		19
USGS 77	Pump 25 gpm		28		29
USGS 78	Bail @ 160 feet			17	
USGS 79	Pump 30 gpm		2		11
USGS 82	Pump 25 gpm	3	3	3	14
USGS 83	Pump 28 gpm		24		38
USGS 84	Pump 5 gpm		36		37
USGS 85*	Pump 23 gpm		3		14
USGS 86	Pump 19 gpm		24		25
USGS 87*	Pump 2 gpm	21	32	21	33
USGS 88	Pump 2 gpm	21	21	21	22
USGS 89	Pump 5 gpm	3	21	3	22
USGS 90	Pump 4 gpm	21	21	21	22
USGS 92	Bail 213 feet		21		8
USGS 97***	Pump 27 gpm		36		37
USGS 98***	Pump 25 gpm		36		37
USGS 99***	Pump 25 gpm		2		11
USGS 100*	Pump 10 gpm#		2		11

Table 5. U.S. Geological Survey field schedule showing well and pump installation and sampling schedules for selected wells and stream-flow sites, 2000—Continued.

[Local site identifier: see figures 1-6 for location of sites. **Abbreviation**: gpm, gallons per minute, pumping rates are approximate; BLR, Big Lost River]

Local site identifier	Method of sampling	Analysis type (see code at back of table)			
		Jan	Apr	Jul	Oct
USGS 101	Pump 13 gpm		24		25
USGS 102***	Pump 29 gpm			14	
USGS 103*	Pump 21 gpm	1	24	1	25
USGS 104*	Pump 26 gpm	1	1	1	10
USGS 105	Pump 24 gpm		24		25
USGS 106	Pump 24 gpm		1		9
USGS 107	Pump 30 gpm		24		38
USGS 108*	Pump 24 gpm		24		25
USGS 109	Pump 22 gpm		24		25
USGS 110A	Pump 24 gpm		24		25
USGS 111	Pump 15 gpm#		3		14
USGS 112*	Pump 30 gpm	3	3	3	14
USGS 113	Pump 25 gpm	3	3	3	16
USGS 114	Pump 10 gpm#	3	3	3	14
USGS 115*	Pump 5 gpm	3	3	3	14
USGS 116	Pump 20 gpm	3	3	3	14
USGS 117	Pump 12 gpm#	3	21	3	22
USGS 119	Pump 3 gpm#	3	21	3	22
USGS 120*	Pump 27 gpm	21	32	21	33
USGS 121	Pump 8 gpm		3		14
USGS 123	Pump 3 gpm		3		14
USGS 124*	Pump 19 gpm		1		10
USGS 125*	Pump 21 gpm		24		25
USGS 126A	Pump 22 gpm		24		25
USGS 126B	Pump 22 gpm		24		25
USGS 127	Pump 25 gpm		26		27

*Samples are collected by personnel from the USGS and the State of Idaho's INEEL Oversight Program

**Samples are collected monthly for organics - SH1380

***Samples are collected quarterly for the NRF study—Nov, Feb, May, Aug.

# Indicates pump rate needs to be cut back to pump rate indicated; all other pump rates are approximate.

Codes for types of analyses (number of bottles needed in parenthesis)

1. ^{3}H, Cl^{-} (2)
2. ^{3}H, Cl^{-}, Cr (3)
3. ^{3}H, ^{90}Sr, Cl^{-} (3)
4. ^{3}H, Cl^{-}, α, β, γ Spec (4)
5. ^{3}H, ^{90}Sr, γ Spec, Cl (3)
6. ^{3}H, ^{90}Sr, Cl^{-}, Cr, SO_4 (4)
7. ^{3}H, ^{90}Sr, γ Spec, Cl^{-}, Cr (4)
8. ^{3}H, ^{90}Sr, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-} (3)
9. ^{3}H, Cl^{-}, Na^{+} (3)
10. ^{3}H, Cl^{-}, Na^{+}, NO_3^{-} (4)
11. ^{3}H, Cl^{-}, Cr, Na^{+},SO_4 (3)
12. ^{3}H, Cl^{-}, Cr, Na^{+}, NO_3^{-}, SO_4^{-} (4)
13. ^{3}H, ^{90}Sr, Cl^{-}, Na^{+}, SO_4^{-} (4)
14. ^{3}H, ^{90}Sr, Cl^{-}, Na^{+}, NO_3^{-},SO_4^{-} (5)
15. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}(5)
16. ^{3}H, ^{90}Sr, γ Spec, Cl^{-}, Na^{+}, NO_3^{-}, SO_4^{-} (5)
17. ^{3}H, ^{90}Sr, Cl^{-}, Cr, Na^{+}, SO_4 (4)
18. ^{3}H, ^{90}Sr, γ Spec, Cl^{-}, Cr, Na^{+}, SO_4 (4)
19. ^{3}H, ^{90}Sr, γ Spec, Cl^{-}, Cr, Na^{+}, NO_3^{-}, SO_4^{-} (5)
20. ^{3}H, ^{90}Sr, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, NO_3^{-}, SO_4^{-} (5)
21. ^{3}H, ^{90}Sr, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, POC's (6)
22. ^{3}H, ^{90}Sr, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, NO_3^{-}, POC's, SO_4^{-} (8)
23. ^{3}H, ^{90}Sr, Cl, NO_3^{-} (4)
24. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-} (6)
25. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-}, TOC (7)
26. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-} (6)
27. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-}, TOC (7)
28. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, Cr, NO_3^{-}, SO_4^{--}, F^{-}, POC's (9)
29. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, Cr, NO_3^{-}, SO_4^{--}, F^{-}, POC's, TOC (10)
30. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-}, SO_4^{--}, POC's (9)
31. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-}, SO_4^{--}, POC's, TOC (10)
32. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, Cr, NO_3^{-}, POC's (9)
33. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, Cr, NO_3^{-}, POC's, TOC, SO_4^{-} (10)
34. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Na^{+}, NO_3^{-}, POC's, Sb, Ar, Cr, Pb, Hg, Ni, Tl, Zn (12)
35. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Na^{+}, NO_3^{-}, POC's, TOC, Sb, Ar, Cr, Pb, Hg, Ni, Tl, Zn (13)
36. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+} Cr, NO_3^{-}, SO_4^{--}, POC's, Al, Ar, Ba, Cd, Pb, Mn, Ni, Hg, Se, Ag, Zn (12)
37. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, Cl^{-}, Na^{+}, Cr, NO_3^{-}, SO_4^{--}, POC's, TOC, Al, Ar, Ba, Cd, Pb, Mn, Ni, Hg, Se, Ag, Zn (13)
38. ^{3}H, α, β, γ Spec, Cl^{-}, Na^{+}, Cr, NO_3^{-}, TOC, POC's (10)
39. ^{3}H, ^{90}Sr, Cl^{-}, POC'S (6)
40. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, NO_3^{-}, POC's, SH1254 metals + Ar, V, Mo, Hg, and Fieldalkalinity and D.O. (10)
41. ^{3}H, ^{90}Sr, α, β, γ Spec, ^{241}Am, ^{238}Pu, ^{239,240}Pu, NO_3^{-}, POC's, SH1254 metals + Ar, V, Mo, Hg, , TOC (11)
42. POC's (3)
43. ^{3}H, ^{90}Sr, Cl^{-}, Cr, Na^{+}, NO_3^{-} (5)
44. ^{241}Am, ^{238}Pu, ^{239,240}Pu (1)
45. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Cr, + SH 1281 metals: Ar, Ba, Cd, Cr, Pb, Hg, Se, Ag (8)
46. ^{3}H, ^{90}Sr, α, β, γ Spec, Cl^{-}, Cr, Na^{+}, SO_4^{-} , + total Ar, Ba, Cd, Cr, Pb, Hg, Se, Ag (8)

Appendix 1: Summaries of U.S. Geological Survey reports, 1949–2001 (with U.S. Department of Energy report numbers)

[Throughout the history of the INEEL, many facility-related acronyms have been used (and frequently have changed). A complete list of acronyms used at the INEEL is available on the internet: http://www.inel.gov/media/pdf/acronyms.pdf, and the ones used in this report are listed in the acronym glossary of this report]

IDO–22000–USGS Geology and ground water at Site 7, Reactor Testing Station, Idaho, OFR IDO–22000, by J.R. Jones and P.T. Voegeli, 1951, 27 p. This report presents the areal geology, a preconstruction engineering study, a discharge/drawdown test (18 hours), grain-size distribution, and a composite geologist's/driller's log of an ICPP (now INTEC) borehole. Data were collected in 1950. Authors discuss ground-water occurrence, perching mechanism, and probable contaminant-migration pathways.

IDO–22001–USGS Geology and ground water at Site 2A, Reactor Testing Station, Idaho, OFR IDO–22001, by J.R. Jones and P.T. Voegeli, 1951, 40 p. This report presents the areal geology, a preconstruction engineering study, a pumping test (well MTR 1, now TRA 1), discharge/drawdown tests (well MTR 2, now TRA 2), grain-size distribution of five samples, and composite geologist's/driller's logs of four MTR (now TRA) boreholes. Data were collected in 1950. Authors discuss ground-water occurrence, perching mechanisms, and probable contaminant-migration pathways. The discussion emphasizes hydraulic variability over short distances and the direct influence of barometric pressure on water levels in the unconfined aquifer.

IDO–22002–USGS Geology and ground water at Site 3, Reactor Testing Station, Idaho, OFR IDO–22002, by J.R. Jones, Morris Deutsch, and P.T. Voegeli, 1951, 61 p. This report presents the areal geology, a preconstruction engineering study, discharge/drawdown tests of STR 1 (now NRF 1) at two depths, discharge/drawdown relations of abandoned hole (USGS Field no. 12), grain-size distribution of eight samples, and a composite geologist's/driller's log of one STR (now NRF) borehole. Data were collected in 1950. Authors discuss ground-water occurrence, perching mechanisms, and probable contaminant-migration pathways. The discussion emphasizes hydraulic variability over short distances.

IDO–22003–USGS Geology and ground water at Site 1 and an adjacent area to the east, Reactor Testing Station, Idaho, OFR IDO–22003, by R.L. Nace and P.T. Voegeli, 1951, 17 p. This report presents the areal geology, a preconstruction engineering study, a discharge/drawdown test of EBR 1, hand-specimen and thin-section descriptions of four basalt samples, the grain-size distribution of one Big Lost River surficial sample, and a composite geologist's/driller's log of one EBR borehole. Data were collected in 1950 and 1951. Authors discuss ground-water occurrence, perching mechanisms (including dispersal over a broad area and in unpredictable directions prior to reaching the water table), and probable contaminant-migration pathways. The discussion emphasizes hydraulic variability over short distances.

IDO–22004–USGS Geology and ground water in the central construction area, Reactor Testing Station, Idaho, OFR IDO–22004, by R.L. Nace, J.R. Jones, P.T. Voegeli, and Morris Deutsch, 1951, 61 p. This report presents the areal geology, a preconstruction engineering study, discharge/drawdown tests of wells Navy 1 and 2 (now CFA 1 and 2), the grain-size distribution of four surficial samples, composite geologist's/driller's logs of Navy 1 and 2, and water-chemistry data from 16 samples taken from seven wells (preconstruction, table 2). Data were collected from 1949–51. Authors discuss ground-water occurrence, perching mechanisms (including dispersal over a broad area and in unpredictable directions prior to reaching the water table), probable contaminant-migration pathways, and secondary carbonate mineralization of surficial material. The discussion emphasizes hydraulic variability over short distances. The report also summarizes hydraulic data from STR, CCP, and MTR (table 1).

IDO–22005–USGS Memorandum report on pumping test of Arco Reactor-Testing Station Production Test Well no. 1, with recommendations for well-finishing, OFR IDO–22005, by R.L. Nace, 1949, 6 p. This report presents pumping-test results for well EBR 1.

IDO–22006–USGS Results of pumping test on MTR Production Well 1, Arco Reactor-Testing Station, Idaho, OFR IDO–22006, by J.W. Stewart, 1950, 8 p. This report presents pumping-test results for MTR 1 (now TRA 1).

IDO–22007–USGS Memorandum report on results of pumping test no. 2 on MTR Production Well AC1, Arco Reactor-Testing Station, Idaho, OFR IDO–22007, by J.W. Stewart, 1950, 11 p. This report presents pumping-test no. 2 results for the deepened MTR Production Well 1 (now TRA 1).

IDO–22008–USGS Memorandum report on results of pumping test on STR Production Well 1, Atomic Energy Commission Reactor Testing Station, Idaho, OFR IDO–22008, by J.W. Stewart, 1950, 5 p. This report presents pumping-test results for STR Production Well 1 (STR 1, now NRF 1).

IDO–22009–USGS Memorandum report on results of discharge-drawdown test on Navy Well No. 2, Atomic Energy Commission Reactor-Testing Station, Idaho, OFR IDO–22009, by J.W. Stewart, 1951, 5 p. This report presents discharge/drawdown test results for Navy well no. 2 (Navy 2, now CFA 2).

IDO–22010–USGS Memorandum report on results of pumping test on CPP Production Well No. 1, Atomic Energy Commission Reactor Testing Station, Idaho, OFR IDO–22010, by R.L. Nace and J.W. Stewart, 1951, 6 p. This report presents pumping-test results for the CPP Production Well No. 1 (now CCP 1).

IDO–22011–USGS Results of tests on wells at Sites 3 and 7, Reactor Testing Station, Idaho, OFR IDO–22011, by J.W. Stewart, 1951, 28 p. This report presents construction diagrams for wells STR 1 and 2 (now NRF 1 and 2), and CPP 2 and 3 (now CPP Disposal). It also describes several hydraulic tests and selected results (including recharge) for wells CPP 1, 2, 3, and STR 2.

IDO–22012–USGS Reconnaissance of the geology in the Atomic Reactor Testing Station, Idaho, OFR IDO–22012, by R.L. Nace and J.R. Jones, U.S. Geological Survey, 1950, 19 p. This report summarizes the physiography, areal geology, subsurface and structural geology, and water-bearing properties of rocks at the NRTS.

IDO–22013–USGS Logs of water wells, Reactor Testing Station, Idaho, OFR IDO–22013, by J.R. Jones and S.L. Jones, 1952, 38 p. This report presents composite driller's/geologist's logs of NRF, TRA, ICPP (now INTEC), CFA, and EBR wells.

IDO–22014–USGS Memorandum report on compiled logs of AEC wells STR-2 and CPP-2, OFR IDO–22014, by J.R. Jones and S.L. Jones, 1951, 8 p. This report presents compiled lithologic logs of wells STR 2 (now NRF 2) and CPP 2.

IDO–22015–USGS Logs of test holes in the central Snake River Plain, Idaho, OFR IDO–22015, by J.R. Jones and S.L. Jones, 1952, 96 p. This report presents lithologic logs of 17 sites on or near the NRTS.

IDO–22015–USGS (Supplement 1) Logs of test holes in the central Snake River Plain, Idaho, by J.R. Jones, S.L. Jones, and E.G. Crosthwaite, 1953, 51 p. This report presents lithologic logs of 13 new sites and the deepened part of 3 old sites on or near the NRTS.

IDO–22015–USGS (Supplement 2) Logs of test holes and wells in the central Snake River Plain, Idaho, by P.T. Voegeli and N.B. Crow, 1954, 30 p. This report presents lithologic logs of 12 sites in Butte and Jefferson Counties.

IDO–22015–USGS (Supplement 3) Logs of test holes and wells in the central Snake River Plain, Idaho, by A.E. Peckham, J.R. Houston, and E.H. Walker, 1959, 45 p. This report presents lithologic logs of 35 sites on or near the NRTS.

IDO–22016–USGS Ground-water recharge from the Big Lost River below Arco, Idaho, OFR IDO–22016, by R.L. Nace and J.T. Barraclough, 1952, 31 p. This report presents data on precipitation and Big Lost River discharge, seepage losses, and river stages, etc.

IDO–22017–USGS Water levels in wells in Bingham, Bonneville, Butte and Jefferson Counties, Idaho, OFR IDO–22017, by Eugene Shuter and G.E. Brandvold, 1952, 99 p. This report presents historical data on water levels in 57 wells on or near the NRTS that were measured seven or more times through 1951.

IDO–22018–USGS Investigations at the National Reactor Test Site, Idaho by the U.S. Geological Survey Report of plans, progress and fiscal status, OFR IDO–22018, by R.L. Nace, 1952, 15 p. This report describes early work by the USGS at the NRTS and USGS budget requirements through 1953.

IDO–22019–USGS Geology of Site 14 and vicinity, National Reactor Testing Station, Idaho, OFR IDO–22019, by Morris Deutsch and S.W. West, 1952, 37 p. This report presents the areal geology, a preconstruction engineering study, grain-size distribution of four surficial samples, composite geologist's/driller's logs of three shallow boreholes—USGS 6, 15, and 18—and water-chemistry data for wells USGS 6, 17, and 18 (preconstruction data, table 1). Data were collected during 1950–51. The report discusses ground-water occurrence, perching mechanisms (including dispersal over a broad area and in unpredictable directions prior to reaching the water table), identifies possible perched zones (prior to development), and discusses probable contaminant-migration pathways and geology relative to construction processes. The report also contains a geologic map of the Site 14 area.

IDO–22020–USGS Memorandum report on geologic and topographic features of the northeastern part of the National Reactor Testing Station, Idaho, OFR IDO–22020, by R.L. Nace and J.R. Jones, 1952, 8. p. This report evaluates the effects that these geologic and topographic features would have on construction, water supply, and waste-disposal practices. The authors also discuss a proposed landing-strip site.

IDO–22021–USGS Water supply and waste disposal at proposed ANPR Site, National Reactor Testing Station, Idaho, OFR IDO–22021, by R.L. Nace, 1952, 15 p. This report provides a statement of water-supply needs and estimates of waste-disposal volumes at the ANPR site (now TAN) (mouth of Birch Creek Valley). It provides a summary of the basic problems that needed to be solved prior to development: (1) the adequacy of the ground-water reservoir to supply projected needs; (2) knowledge about the hydraulic gradient, and the direction and velocity of underflow; (3) the desirable locations, construction characteristics, and spacing of production wells (at ANPR and other sites); (4) the depth to water, drawdown, and lift in wells of specified capacity; (5) the general water quality; (6) the feasible types of fluid-waste-disposal facilities; and (7) the locations of waste-disposal facilities and required space relations relative to other ANPR and off-ANPR facilities. The report provided detailed responses to answer these questions, and many of the answers reflect 1998 scientific thought on these questions, notably, the prediction of local variation of the hydraulic gradient relative to the regional gradient, the preferred ground-water flowpaths in the vicinity of the site, and the anomalous water chemistry between wells at the site. This report presents a lithologic log of USGS 24 and temperature data for wells USGS 24 and USGS 7. The report mentioned the waste-disposal characteristics of the

layered basalt relative to impermeable zones, which recently were verified by tomography and acoustical methods.

IDO–22022–USGS Geology and ground water in the northeastern part of the National Reactor Testing Station, Idaho, OFR IDO–22022, by Morris Deutsch, P.T. Voegeli, R.L. Nace, and J.R. Jones, 1952, 61 p. This report indicates that the Big Lost River began to contribute water to playas in 1951 and that they remained ponded through 1952, presents grain-size information for several types of deposits in the northeastern corner of the NRTS, indicates that sources of ground water in the northeastern corner are underflow from Birch Creek and Mud Lake and local precipitation, and that perched water located in several wells was attributed to recharge from precipitation. The report also gives drawdown measurements for several wells, presents chemical data and driller's reports for 12 wells, and gives structural and engineering controls on materials (such as, stability, weather conditions, difficulties in drilling in materials, and how liquid waste disposal might be affected by the lithology) where proposed buildings were to be put.

IDO–22023–USGS Geology, ground water, and waste-disposal at the Aircraft Nuclear Propulsion Project Site, National Reactor Testing Station, Idaho, OFR IDO–22023, by Morris Deutsch, R.L. Nace, and P.T. Voegeli, 1952, 45 p. This report presents more formally the information contained in IDO–22021–USGS and provides more detailed responses to the questions posed in that report. Many of the 1952 responses reflect 1998 scientific thought on those questions, notably, the prediction of local variation of the hydraulic gradient relative to the regional gradient, preferred ground-water flowpaths in the vicinity of the ANPR (now TAN), and different water chemistry for wells at the ANPR. This report presents (1) lithologic logs of wells USGS 7, 24, 25, and 26; water-chemistry data for wells USGS 4, 7, 18, 21, 24, 25, 26, and 2nd Owsley (including conditions during water-sample collection and a listing of maximums and minimums for 30 samples from these wells); (2) grain-size analyses for seven surficial samples from the ANPR area; and (3) water-level data for wells USGS 24, 25, and 26 (see p. 13). The report identifies Birch Creek and Mud Lake underflow as the major source of recharge in the ANPR area; notes that the hydraulic gradient is flat in some places but changes as much as 10 ft/mi in other places, and that the regional flow direction is generally south to southwest although local flow directions change from southeast to southwest; contains a potentiometric map for October 1, 1952; makes predictions regarding the effects of waste disposal using new estimates of future waste quantity and type, and the direction of waste movement and effects on offsite users; and recommends locations for various disposal options. The report also predicts that ground-water chemistry will vary with depth (with water less than 400 ft deep being a Ca-CO_3 character, being moderately hard to hard, having a pH between 7.0 and 8.0, having a temperature of about 55 °F, and containing trace amounts of B and Mn). The report has a fence diagram showing the local stratigraphy of the ANPR site.

IDO–22024–USGS Altitude and configuration of the water table beneath the National Reactor Testing Station, Idaho, OFR IDO–22024, by R.L. Nace, 1953, 5 p. This report presents a water-table map of the NRTS adjusted to October 1, 1952. The report presents methods and some contouring theory used to construct the map and some conclusions drawn from the map. Authors hypothesized differing local horizontal directions of flow in the vertical section at a point, which are possibly related to permeability changes of the rock with depth (that is, fractures, flow contacts, and interbeds).

IDO–22025–USGS Potential construction sites in the central western part of the National Reactor Testing Station, Idaho, OFR IDO–22025, by P.T. Voegeli and S.W. West, 1953, 9 p. This report presents an evaluation (including geology) of potential construction sites in seven areas in the central western part of the NRTS (Sites 13 and 13A, 31, 32, 33, 34, 35, and 36) that would be located under the proposed nuclear airplane flyway.

IDO–22026–USGS Geology and hydrology of Site 6, National Reactor Testing Station, Idaho, OFR IDO–22026, by Morris Deutsch, 1953, 20 p. This report presents the findings of a study of Site 6, including the general geologic and hydrologic characteristics of the area; a geologic map; grain-size analysis of three Big Lost River sites; one auger hole, and two dune samples in the area; graphical logs of several shallow test borings; ranges of cation exchange capacities from RWMC lithologic materials similar to the ones found at Site 6 (includes a discussion of the potential for ion exchange to retard contaminant migration); a driller's/geologist's log of well USGS 17; and six water-chemistry analyses of water from well USGS 17 along with conditions at the time samples were collected.

IDO–22027–USGS Geology, water supply, and waste disposal at Sites 11 and 11A, Burial Ground D, and vicinity, National Reactor Testing Station, Idaho, OFR IDO–22027, by P.T. Voegeli and Morris Deutsch, 1953, 42 p. This report presents the findings of a study of Sites 11, 11A, and Burial Ground D (now RWMC). The report includes general geologic and hydrologic characteristics of the areas; a geologic map; grain-size analysis results of 7 samples from test pits in the area; logs of several shallow test borings and dragline excavations; lithologic logs of wells EBR 1, USGS 9, and USGS 22; cation exchange capacities for 37 samples from the Burial Ground D and Site 11 and 11A pits and boreholes (includes a discussion of the potential for ion exchange to retard contaminant migration); mineralogy data for 20 samples of unconsolidated material at Burial Ground D; and 12 water-chemistry analyses of water from wells USGS 9, USGS 22, and EBR 1 along with conditions at the time samples were collected.

IDO–22028–USGS Geology and ground-water resources of a part of western Jefferson County adjacent to the National Reactor Testing Station, Idaho, OFR IDO–22028, by Morris Deutsch, R.L. Nace, and Eugene Shuter, 1954, 24 p. Much of western Jefferson County later was assimilated into the NRTS, probably as a result of this study. Table 1 summarizes

the hydrologic and construction properties, distribution, and characteristics of the geologic materials in the area that are included on the geologic map. The report identifies perched zones in the northeastern part of the study area and notes local variation from the regional flow direction. It gives discharge/drawdown information for wells USGS 30 and 31, estimates of transmissibility for the Snake River Plain aquifer, and match-book cover calculations of total underflow onto the NRTS across an 8-mile strip of aquifer. Contains water-chemistry data for 24 samples from wells USGS 4, 21, 26–33, and 2nd Owsley. The report contains a discussion of the amount and location of natural discharge from the Snake River Plain aquifer, a graphical representation of grain-size analysis results of six surficial samples in the area, graphic lithologic logs of wells USGS 4 and USGS 27–33, and geologic and water-table contour maps from April 1953. Table 2 presents records of wells in the study area.

IDO–22029–USGS Progress report on operations of stream-gaging station, Big Lost River near Arco, Idaho, Water Year 1953, OFR IDO–22029, by W. I. Travis, 1954, 4 p. This report describes the gaging station Big Lost River near Arco, Idaho, which was rebuilt in October 1952, and presents instantaneous maximum and minimum measurements for the period of record, discharge records for water year 1953, a flow-duration curve for 1947–53, a bar chart showing mean annual flow for 1947–53, and a hydrograph for 1952–53.

IDO-22030-USGS Progress report on operations of stream-gaging station, Big Lost River near Arco, Idaho, water year 1954, OFR IDO-22030, by W.I. Travis, 1955, 4 p. This report describes flooding on two tributaries of the Big Lost River upstream from Mackay Reservoir: Wildhorse Creek (3,490 ft^3/s) and Fall Creek (2,160 ft^3/s). The report also mentions an irrigation district agreement to raise the level of Mackay Dam by 5 feet, however, construction was not started during the year. This report presents instantaneous maximum and minimum flow for 1947–54, a station description with 1954 extreme measurements, daily discharges along with monthly and annual summaries for water year 1954, and a hydrograph showing daily discharge for water year 1954.

IDO-22031-USGS Water supply and waste disposal for proposed Engineering Test Reactor, Large Ship Reactor, and Organic-Moderator Reactor Experiment, National Reactor Testing Station, Idaho, OFR IDO-22031, by R.L. Nace, 1955, 18 p. This report makes some predictions about drawdown and transmissivities in the basalt aquifer. The assumption (first advanced in a general sense by C.V. Theis) that flow in the fractured Snake River Plain basaltic aquifer can be approximated on a regional scale by the mathematics of flow in a homogeneous and isotropic medium was first presented for the NRTS in this report. Specific recommendations were made for the three sites as follows:

MTR (now TRA) site.—That one new well with a 4,000 gpm pump be constructed 100 ft east of well MTR 1 (now TRA 1); that the capacity of MTR 1 be increased to 3,000 gpm by installing a new pump; that contingency plans be made for installing an additional well if the other two wells did not provide an adequate supply, including standby requirements; and that if a second new well was required, it would be constructed so as to eliminate the need for MTR 1.

STR (now NRF) site.—That the capacity of wells STR 1 and 2 (now NRF 1 and 2) be increased to 2,000 gpm or more by installing new pumps; that a new well with a capacity of 4,000 gpm or more be drilled between STR 1 and 2; and that provision be made for the drilling of a second new well if the execution of the previous recommendations did not provide an adequate supply, including a standby supply.

OMRE site.—That one well be constructed to supply the site giving consideration to the specific hydraulic predictions included in the report.

IDO-22033-USGS Geography, geology, and water resources of the National Reactor Testing Station, Idaho, Part 1: Purpose, history, and scope of investigations, OFR IDO-22033, by R.L. Nace, 1956, 68 p. This report summarizes the purpose, history, and scope of early U.S. Geological Survey (USGS) investigations at the NRTS, and gives a brief history of the area during World War II when it was a Navy gunnery range and an Air Force bombing range. The report describes early USGS reconnaissance work in the area, the selection of the Pocatello area as the location of the NRTS, and the original work elements and funding agreements for USGS studies at the NRTS. The report gives the status and history of reactor/facility construction and development for EBR, MTR, ETR, STR (S1W), LSR (A1W), ANP and IET, SPERT, OMRE, CPP, CFA, BG (RWMC), and BORAX I, II, and III (the Experimental Boiling-Water Reactors).

The report describes in detail the basic investigations at the NRTS, which included: geologic mapping; test drilling (this section gives a comprehensive description of the timing, purpose, and cost of drilling wells USGS 1–40 and the facility-production wells drilled up to that point in time); geophysical exploration; a canvass of wells and water levels (see p. 29 for a description of the logic behind the location and timing of water-level measurements); spirit leveling; surface-water investigations; chemical and radiometric analyses; hydrology of the basalt; amount of water available in the aquifer; construction of wells and the effects of pumping; and laboratory analytical work.

The report also briefly summarizes the research investigations at the NRTS, which included studies on the permeability of geologic materials, infiltration and percolation rates, hydraulics of basalt aquifers, ion exchange, and equipotential surveying (a proposal originated by Herb Shbitzke to introduce salt into a borehole and monitor its migration in the aquifer is included in this section).

The report also discusses coordination with other USGS studies on the Snake River Plain (which is a precursor to the USGS's cooperative-funding program), emphasizes access to the expertise of the USGS's National Program (which is a precursor to the USGS's National Research Program), lists professional meetings attended by the USGS staff and reports

published through 1955, gives a summary listing of USGS personnel, their tasks, and time of service at the NRTS (table 3), and provides a map showing the locations and types of studies conducted by the USGS at the NRTS (plate 1).

IDO-22033-USGS Geography, geology and water resources of the National Reactor Testing Station, Idaho, Part 2: Geography and geology, by R.L. Nace, Morris Deutsch, and P.T. Voegeli, 1956, 225 p. This is a comprehensive interpretive report on the geology and geography of the NRTS. It summarizes and synthesizes the previous reports on these subjects and introduces large amounts of new data such as mineralogy and rock chemistry. The report provides information on the physiographic setting, climate, ground conditions, cultural development, general geologic setting, recent geologic events, geologic materials and their surface distribution, special geologic factors such as ion-exchange properties, desiccation features, earth cracks, geologic structures, subsurface geology, and geology in relation to construction. This report presents a comprehensive geologic color map of the entire NRTS, which also shows water-table contours for April 1953.

IDO-22033-USGS Geography, geology and water resources of the National Reactor Testing Station, Idaho, Part 3: Hydrology and water resources, by R.L. Nace, J.W. Stewart, W.C. Walton and others, 1959, 253 p. This report describes the hydrology and evaluates the water resources of the NRTS, sets these in a regional perspective, and forecasts conditions and effects in future years. It summarizes and synthesizes the work that is partially covered in previously published reports and introduces large amounts of new data and interpretations. Plates included in the report are important contributions to the INEEL knowledge base and include: well locations; water-table contours, April 1953; water-table contours, October 1956; depth to water, April 1953; and chemical quality of ground water at the NRTS, 1955, before waste-disposal effects.

The report also contains: maximum and minimum instantaneous and mean annual discharge for the Big Lost River (BLR), 1947–55; discussions of BLR discharge in 1951 and 52 with a description of upstream flooding at Arco, the resultant increased flow at the NRTS, and the results of an infiltration rates study on the BLR channel, 1951–53; calculated BLR playa infiltration rates, 1952–53; a discussion of Little Lost River, Birch Creek, and local runoff characteristics at the NRTS and vicinity; a discussion of flood and erosion hazards and bed-erosion possibilities on the BLR; velocity-maximum depth-discharge relations for the BLR during the 1951–53 high-flow period; surface-water chemistry data for the BLR; a detailed description of the occurrence of ground water at the NRTS including depth to water, configuration of the water table (with apparent changes between 1953 and 1956), underflow, perched water (both natural at USGS 7 and artificial at the MTR, now TRA), quasi-artesian character in places, and unexplained phenomena (head reversals at CFA); a discussion of the water-bearing properties of basalt including the types of openings, the pore-water content and porosity, infiltration and percolation rates (describes the relation of BLR flow and the ground-water levels nearby in well MTR Test and 12 mi distant in well USGS 1), specific-capacity data (wells CFA-2, EBR 1, MTR-1, -2, CCP-1, -2, -3, NRF-1, -2, USGS 12, 30, 31, ANP-1, -2, and average values for several counties located on the Snake River Plain), and various types of hydraulic tests at the ANP (now TAN) and CCP (now INTEC) areas (time-drawdown, distance-drawdown, and the generalized composite drawdown graphic method of Cooper and Jacobs (1946)); a discussion of the water-bearing properties of sediments including infiltration rates in gravel at the MTR and in the BLR channel, laboratory permeabilities of coarse-grained materials (table 15), and of fine-grained materials (table 17); a discussion of the ground-water hydrology including recharge (from precipitation, surface-water infiltration, and underflow from tributary valleys and the Mud Lake Basin), the amount of water in storage, the nature of ground-water movement (including rates, regional and local directions, and the amount of underflow at the NRTS), potential ground-water development and the effects on the NRTS (estimates of irrigation pumpage on the Snake River Plain in 1955, table 18), and natural and artificial (pumping) discharge from the Snake River Plain aquifer system and where it occurs; a discussion of the fluctuations of the water table at the NRTS including those with no associated change in ground-water storage such as seismic, wind, and barometric changes and those with an associated change in storage such as local recharge from infiltration of BLR water, seasonal variations in recharge or withdrawals, and changes due to long-term trends caused by pumping, irrigation diversions and returns, regional variations in weather patterns, or from changes in the regional surface-water regimens; and a discussion of the chemical quality of ground water at the NRTS including the following observations:

(a) that water shallower than 1,200 ft is relatively uniform in chemical composition except for some minor depth and areal variations,

(b) that this generally holds true both at the NRTS and across the SRPA (table 24 gives a summary of maximum, minimum, and mean concentrations for wells at the NRTS and the central SRPA),

(c) that beta-gamma activity and sodium can be used as indicators of contamination but that none has been discovered by the Atomic Energy Commission to date,

(d) that the unweathered nature of the basalt implies that very little dissolution is occurring,

(e) that the water is predominantly calcium plus magnesium-bicarbonate in character,

(f) that increases in calcium and chloride concentrations above background concentrations often reflect the concentration effects of evaporation on irrigation return flow,

(g) that deep water from well USGS 15 is significantly different from other nearby shallow SRPA water and that the difference probably is due to upwelling of water from depth (see p. 247),

(h) that higher water temperatures of water from wells along the edges of the SRP probably reflect geothermal water moving up along mountain border faults,

(i) that beta-gamma activity due to background sources is small and therefore likely to be a good indicator of contamination resulting from waste disposal,

(j) that the small dissolved solids load of water in the SRPA results from the low solubility of basalt minerals and the relatively large ground-water velocities in the aquifer, which result in a shorter residence time with less opportunity for the water to dissolve the minerals, and

(k) that the chemistry of the ground water at the NRTS is dominated by the mixing of waters from the tributary valleys with water from other sources such as the Mud Lake Basin.

At the time this report was written, all activities at the NRTS had been of a characterization nature. In the last sentence of this report, the author indirectly references a new phase of USGS activities that was about to be initiated at the NRTS—that of monitoring water quality with the intent of detecting and tracking ground-water contamination.

IDO–22033–USGS Geography, geology, and water resources of the National Reactor Testing Station, Idaho, Appendix 1: Basic data on the geography and geology, by R.L. Nace, Morris Deutsch, P.T. Voegeli, and S.L. Jones, 1956, 60 p. This report summarizes previously published data and new data used in Part 2 of this series. Soil temperature data for shallow soil (2.7 ft deep) was collected adjacent to well MTR-test at 3-hour intervals for the period November 1952 to December 1953 and is included in table 1. Analytical methods for measuring the soil temperatures in table 1, mineralogy by X-ray diffraction (data in Part 2), ion-exchange capacity (table 2), and grain-size analysis (data in Part 2) are included in this report. This report presents logs of 5 shallow test borings and dragline test pits 1–6 at the RWMC. Drilling rates are provided for 13 test holes (USGS 1–13) and an abandoned hole, USGS 3A. Case histories depicting difficulties in drilling at the NRTS are provided by operational logs for wells USGS 12 and USGS 15. Graphical lithologic logs, construction diagrams, selected geophysical logs (natural gamma logs), and principal occurrences of surficial and interbed materials are provided for wells USGS 1–39, USGS 3A, MTR-test, 2nd Owsley, ANP-1, -2, -3, CFA-1, -2, CCP-1, -2, -3, EBR-1, Hwy-1, 2, IET-1, MTR-1, -2, -ab, Spert-1, and STR-1, -2.

IDO-22034-USGS Geography, geology, and water resources of the National Reactor Testing Station, Idaho, Appendix 2: Basic hydrology data, OFR IDO-22034, by J.W. Stewart, R.L. Nace, K.H., Fowler, A.E. Peckham, and P.T. Voegeli, 1960, 247 p. This report is a compilation of basic hydrologic data used in the preparation of Part 3. It contains a wealth of hydrologic and chemical data collected during the period 1949–56. Data collected after 1955 were published in separate, later reports.

Surface-water data.—Daily discharges of the Big Lost River (BLR) near Arco, water years 1947–56, are provided in table 1; annual hydrographs for BLR are graphically provided in figures 1–9a; a flow-duration curve for 1947–55 is shown in figure 10; miscellaneous measurements of discharge for the BLR (1951–53) are provided in table 2; maximum-minimum BLR discharges for 1951–53 are in table 3; and representative cross-sections of the BLR channel are shown in figure 11.

Ground-water-level data.—Water levels for representative wells in the Snake River Plain in October 1952, April 1953, and January 1956 are listed in table 4 and are plotted on water-level maps (pls. 1–3); a summary of wells used in the water-level monitoring program between 1949 and 1956 is provided in table 5 and listed by type of well and by county; water-level fluctuations in these wells during 1949–55 are shown in figures 12–87; quasi-artesian conditions in the SRPA are shown in detail for two wells (USGS 15 and 12) in tables 6–7, and for all wells in table 8.

Aquifer-test data.—A summary of 25 discharge and 5 recharge aquifer tests and some well-construction data are provided in table 9; the tests and conditions during the tests at various facilities are described on p. 72–93; and water-level fluctuations during the tests are shown graphically on figures 88–121.

Water-chemistry data.—Results of 121 chemical analyses of ground-water samples from the NRTS collected during the period 1949–55 are provided in table 10, and explanatory notes to table 10 are listed on p. 147–156; results of 132 chemical analyses of ground-water samples from the central Snake River Plain collected during the period 1949–55 are provided in table 11, and explanatory notes to table 11 are listed on p. 174-183; radiometric analyses (beta-gamma and alpha activity) of water from 152 individual samples and ranges of radiometric analyses (beta-gamma and alpha activity) of water from more than 2,890 samples collected during the period 1949–55 (most were collected and analyzed by the Atomic Energy Commission (AEC)) are provided in table 12; sodium concentrations are shown graphically in figures 122–132 for water sampled as part of the AEC's site-monitoring plan.

Well-record data.—Well records for test holes on or near the NRTS, production wells on the NRTS, and selected wells on the central Snake River Plain are given in table 13, 14 and 15, respectively.

IDO-22035-USGS Geography, geology and water resources of the National Reactor Testing Station Idaho, Part 4: Geologic and hydrologic aspects of waste management, OFR IDO-22035, by R.L. Nace, 1961 (Revised 1964), 223 p. **The first release of radioactive waste at the NRTS occurred in 1952 at the TRA.** The USGS and Atomic Energy Commission (AEC) collected alpha-, beta-, and gamma-activity data at the NRTS prior to waste disposal to establish

background levels in the Snake River Plain aquifer. The USGS suspended collection in 1958 and the AEC continued collection. This report makes the philosophical observation that dangerous or potentially dangerous contamination of ground water can be avoided

(1) by using waste-disposal methods that take advantage of favorable geologic, hydrologic, and geochemical factors that affect waste behavior in the ground, and

(2) by controlling the amount and kind of waste released in accordance with the natural limitations in the environmental capacity to absorb contaminants.

The report also states the USGS's non-advocacy of disposal of radioactive waste (p. 94). The purpose of the report is to examine waste management in relation to geologic and hydrologic facts and principles. The report summarizes knowledge gained in the early period of investigations, suggests ways to apply the information, and outlines some desirable additional studies.

The report presents the AEC principles governing waste disposal: waste management and disposal must be safe, and waste-disposal requirements and standards must be physically and economically feasible.

The report contains discussions of the classification of radioactivity levels in waste, the sources of waste at the NRTS, and the waste-management standards and practices. It also contains a discussion of the general situation and problems regarding waste disposal at the various facilities. Total disposals of radioactive waste (including the types and amounts of waste) for 1952–62 (tables 1–12) was discussed by facility. The natural physical, hydrologic, geochemical, and seismic factors affecting the feasibility of waste disposal at the NRTS were discussed in this report. The report also contains a discussion of the implications that natural factors have on the capacity of the ground to accept waste, on the recirculation of waste liquid, on ion exchange in sediments and rocks (table 13 gives cation exchange capacity (CEC) values for four fine-grained and five coarse-grained samples), on evaporation, on water velocity, and on the nature of ground-water flow (with consideration of mixing, and density and thermal effects). The report contains discussions of the hazards of storing high-level liquid and calcined waste, and the practicality of shallow and deep ground disposal of liquid wastes and potential locations for waste disposal are discussed. Ground disposal of solid wastes also was considered. The report emphasizes the importance of land- and water-conservation in waste management, in controlling the waste composition, and in minimizing the waste volume as much as possible. The report also made suggestions regarding waste-management practices at the NRTS.

IDO-22036-USGS Analysis of aquifer tests at the National Reactor Testing Station, Idaho, 1949–57: OFR IDO-22036, by W.C. Walton, 1958, 32 p. This report summarizes the results of 49 aquifer tests done during 1949–57, including 20 previously unpublished tests done during 1956–57. Results are tabulated in tables 1–3. The report also includes suggestions regarding optimum depth for wells at various facilities at the NRTS.

IDO-22036-USGS Analysis of aquifer tests at the National Reactor Testing Station, Idaho, 1949–57, Appendix: by W.C. Walton, 1958, unpaginated. This report is a compilation of raw aquifer-test data used in IDO-22036-USGS.

IDO-22039-USGS Investigation of underground waste disposal, Chemical Processing Plant Area, National Reactor Testing Station, Idaho, OFR IDO-22039, by A.E. Peckham, 1959, 35 p. This report is important because it describes the first USGS monitoring to define and track waste plumes. Drilling contracts were awarded for 15 monitoring wells (USGS 34–48) to define the sodium-chloride (Na-Cl) plume and any detectable radioactive constituents emanating from the ICPP injection well. The contracts were as follows: 1954 (USGS 34), 1955 (USGS 35–39), 1956 (USGS 40–43), and 1957 (USGS 44–48). Conclusions based on the drilling and monitoring program were that the plume was broader than expected, that local flow-direction reversal occurred as a result of head buildup at the injection well, and that flow and contaminant migration occurred as a result of water movement along preferential pathways associated with basalt structure (including interflow zones, fracture patterns, and the presence of sedimentary interbeds). Table 1 gives records of wells in the ICPP area, and table 2 gives maximum Cl concentrations in water from wells USGS 34–48. Some additional observations stated directly for the first time were that:

(1) waste had been disposed to the injection well (perforated 40 ft above and 100 ft below the water table), to two shallow, open-bottom manholes, and to an open infiltration basin (sewage);

(2) the complex waste contained an average Cl concentration of about 250 mg/L;

(3) normal (background?) Cl concentration was about 10 mg/ L;

(4) seepage from the Big Lost River caused local variations in the configuration of the water table and the direction of local ground-water movement;

(5) higher ground-water temperature was correlated with increased concentrations of chloride;

(6) temperature and chloride concentrations varied with depth; and

(7) fault and fissure-eruption zones may act as hydraulic boundaries, particularly in the CPP (now INTEC) area.

IDO-22040-USGS Analysis of aquifer tests, January 1958–June 1959, at the National Reactor Testing Station, Idaho, OFR IDO-22040, by E.H. Walker, 1960, 37 p. This report provides specific capacity data and coefficients of transmissibility for aquifer tests conducted by the USGS at

the NRTS in 1958 and the first half of 1959. Five wells were tested (FET Prod. #1 and #2, now CTF 1 and 2; EBR 2#1, now EBR II-1; Fire Sta. 2; and GCRE, now ARA 3). The raw data and graphical analyses are provided in tables and illustrations, and well-construction data is provided in table 1.

IDO-22041-USGS Hydrology of radioactive waste disposal at the Idaho Chemical Processing Plant, National Reactor Testing Station, Idaho, OFR IDO-22041, by P.H. Jones, 1961, 8 p. This report describes the use of borehole geophysics to provide data for analysis of the hydrologic aspects of disposal and attenuation at the NRTS. The value of the report is that it identifies the intercept wells designed for tracking contaminant migration from the ICPP Disposal well (now CPP 3). The report also shows the use of geophysical techniques at the NRTS (for the first time) to be useful in identifying the hydrologic characteristics of the aquifer and the distribution of the sodium-chloride (Na-Cl) plume. Table 1 shows the volume of waste delivered to the ICPP Disposal well, including the curies of beta-gamma and alpha radioactivity by year for 1953–60 and the totals for the entire period. Figure 1 shows the thickness of the so-called “540-ft” aquifer, which is the best aquifer (zone?) in the upper 700 ft of the Snake River Plain aquifer. Figure 1 also shows the location of the 16 older (USGS 34–49) and five newer (USGS 51, 52, 57, 59, and 67) intercept wells. Figure 2 shows natural gamma and caliper logs and figure 3 shows resistivity and temperature logs for wells USGS 43, 47, 49, and 59 (both figs. 2 and 3 also show lithologic logs for these wells). Figure 4 shows the 1960 distribution of Na in the ICPP (now INTEC) study area.

IDO–22042–USGS Hydrology of waste disposal, National Reactor Testing Station, Idaho: An Interim Report, OFR IDO–22042, by P.H. Jones, 1961, 62 p. For this report, the author used the data from IDO–22041–USGS to make comprehensive hydrologic interpretations about the ICPP (now INTEC) and MTR-ETR (now TRA) study areas (figs. 6–8, 12–14). ICPP: Jones concluded that aqueous radioactive and chemical wastes discharged to the disposal well in the ICPP area flow radially away from the disposal well in a multiple-aquifer system in the Snake River basalt. The regional gradient in head southwestward causes the wastewater to move generally in that direction; however, locally the preferred direction is a function of the geometry of the aquifer system. Flow rates and flowpaths could be analyzed effectively only by studying each aquifer singly. Accordingly, the five principal aquifers that occur locally in the 460 to 660 ft depth interval were identified as aquifers A, B, C, D, and E. These were mapped with reference to thickness and structure (figs. 9–11, 15–27) and tested individually for head (figs. 28–34) and water quality (figs. 38–55, and 56–58). To obtain hydraulic and chemical data from aquifer D (considered the best flow zone), the flow zone was isolated by packers and fit with pressure transducers to obtain the desired data. The report also proposes a tracer test in aquifer D to look at movement of wastes. MTR-ETR: Jones observed that aqueous radioactive and chemical wastes discharged to an infiltration pond located near the MTR-ETR area were identified in a perched water body of elliptical shape underlying the pond. The configuration of the perched water body, the head distribution, and the chemical characteristics of the perched water body are shown in figures 62–70. Jones also concluded that contaminants had not migrated to the Snake River Plain aquifer beneath the perched water body except for limited migration in the boreholes of aquifer wells. As a result of this discovery, the Halliburton method of grouting was employed to remedy the leakage problem in these wells.

IDO–22043–USGS Chemical and physical character of ground water in the National Reactor Testing Station, Idaho, OFR IDO–22043, by F.H. Olmsted, 1962, 81 p., 19 figs., 11 tables. This report briefly summarizes significant reports about the NRTS that were published between 1902 and 1961. On page 11, Olmsted observes that velocity and direction of flow can vary locally depending on the character of the aquifer and that the regional representation of the flow system is useful for describing water chemistry.

The report contains analytical results for 148 samples collected from 92 wells during the period 1949–61 (Table 1). Listed in table 1 are results from all the reliable samples collected during 1949–56 that were published in IDO–22034–USGS (Appendix 2). Olmsted used the data in table 1 to categorize ground water at the NRTS into four chemical types (A-D) on the basis of proportions of dissolved ions (an early use of the concept of hydrochemical facies, see fig. 2):

A—Calcium and magnesium constitute more than 85 percent of the cations and bicarbonate constitutes more than 70 percent of the anions;

B—Calcium and magnesium constitute less than 85 percent of the cations (that is, sodium and potassium constitute more than 15 percent of the cations) and bicarbonate constitutes more than 70 percent of the anions;

C—No limits on cations but bicarbonate constitutes less than 70 percent of anions; and

D—No limits on cations; bicarbonate constitutes less than 70 percent and sulfate constitutes more than 30 percent of the anions.

Type A water represents recharge from the north and northwest, where the predominant rock type is limestone and dolomite. Type B water represents recharge from the east and northeast, where the dominant rock type is silicic volcanic rocks. Types C and D waters represent recharge from waste disposal, agricultural water use, and other sources such as thermal springs. Olmsted also mapped these areas (figs. 7–10) and made the first delineation of two zones of water quality that roughly divide the NRTS along a northeast-southwest trending line. Variations of water chemistry through time were determined to be the result, for the most part, of waste disposal. Exceptions were the chemistry of water in wells USGS 6 and 20, which were deepened, and water in wells USGS 2, 5, 30, and CFA 2. Variations of water chemistry with depth were observed in USGS 7 and 15, and were attributed to mixing caused by upward flow of water from the deeper silicic rocks. Olmsted also noted a zone of more dilute water

floating on top of more mineralized water and attributed this to local recharge of infiltrating precipitation or locally ponded surface water. This layer is less than 50 ft thick and is present everywhere except at the mouth of the Birch Creek Valley. The report describes the method used for converting resistivity logs to conductance logs.

Temperature was found to be less variable vertically than areally (in the upper 200 ft of saturated material). This was attributed to shallow surface-water recharge from the Big Lost River channel, Mud Lake, the playas, and the spreading areas. Higher temperature wastewater equilibrates rapidly with aquifer water after disposal. Olmsted concluded that density differences of waste relative to native ground water affect the waste movement. When initially injected, waste was sufficiently warm to decrease the density relative to ground water and cause the wastewater to float. As the wastewater cooled, dissolved-solids content became more prevalent and the density was higher relative to ground water, which caused the wastewater to sink. Temperature also caused variability in viscosity; if hydraulic conductivity is held constant, water at 67 ºF moves 23.6 percent faster than water at 49 ºF. This might help explain local variability in flow velocity and direction.

Finally the report makes specific recommendations for future work. Locations for 10 additional monitoring wells were identified to help fill in data gaps. It was also recommended that systematic sampling for water quality be initiated on a regular time schedule and for a specified set of constituents.

IDO–22044–USGS Hydrology of waste disposal, National Reactor Testing Station, Idaho. Annual Progress Report 1962, OFR IDO–22044, by D.A. Morris and others, 1963, 98 p., 48 figs. This report describes in detail several early USGS studies at the NRTS, both small-scale and sitewide, and provides a roadmap for future work.

Small-scale studies.—Fluorescein dye was used at the MTR-ETR (now TRA) to evaluate lateral movement of perched water. Some striking observations were noted. Lateral movements of perched waters at MTR/ETR were identified as follows:

(1) Perched water in shallow alluvium, as much as 20 ft/hour;

(2) Perched water in moderately deep zones, 1.5 to 4.9 ft/day; and

(3) Perched water in deeper zones, as much as 10 ft/day.

In 1956, the background concentration of tritium was estimated to be less than 150 pCi/L. Tritium was first discovered in the aquifer in 1962 at well MTR Test (66,240 pCi/L) and was attributed to leakage down the casing of water that originated from the MTR pond. Monitoring of tritium in ground water and the waste stream was initiated at that time. At the ICPP (now INTEC), tritium was used to estimate ground-water flow velocities by first-arrival time (19–141 ft/day with an average of 60 ft/day) and by center-of-mass methods (10–13 ft/day). At the MTR-ETR and ICPP areas, sodium was evaluated as a potential indicator for pH, specific conductance, beta activity, and gamma activity. No correlations were observed and sodium sampling was reduced to the level required for monitoring long-term trends.

At the MTR-ETR a comprehensive, 60-day study to identify the effects of attenuation, dispersion, and dilution was conducted during October and November 1962. One of the important conclusions was that zones of higher permeability exist in the subsurface.

Also at the MTR-ETR, a study to estimate infiltration rates caused by increasing the water level in the ponds indicated that 16,000 to 50,000 gal/hour infiltrated through the pond bottoms. Several basalt test holes and 37 auger holes were drilled near MTR-ETR to recover solid-phase material, to delineate perched-water bodies, to measure water levels, to collect water samples, and to provide access for neutron-moisture and natural gamma logging.

Sitewide studies.—Water levels were measured (1,050 measurements) as part of a comprehensive water-level monitoring program and to develop a sitewide water-level map, water-level change maps for different time periods, and several hydrographs. From these data it was concluded that a barrier to horizontal flow, oriented approximately north to south, exists in the subsurface. East of the barrier, Mud Lake recharge controls water levels. West of the barrier, wells respond to recharge from Birch Creek and Little Lost River. In 1962, recharge by surface infiltration of snowmelt and high rainfall was significant.

About 2,000 ft of drilling took place in 1962, and about 700 ft was for the purpose of locating a "Burial Ground Site." A total of 109,000 ft of hole was logged by gamma-ray, density, borehole-diameter, water-resistivity, water-temperature, or experimental magnetometer techniques.

A comprehensive water-quality sampling program was initiated in 1962. Seventeen complete water samples and 450 to 900 water samples each for tritium, specific conductance, sodium, and gamma radiation were collected. Other USGS offices were conducting research using petrologic, magnetic, and deep-seismic studies.

Roadmap.—A roadmap for USGS activities at the NRTS was put forth and included continuing small-scale site-specific studies and extending the scope of operations to more accurately describe the regional hydrogeologic environment at the NRTS. Techniques to be used included regional geophysical studies to define the depth of the aquifer, hydraulic and tracer-test studies to refine rates and directions of ground-water flow, and additional studies to refine the knowledge of water chemistry.

IDO–22045–USGS Completion report for observation wells 1 through 49, 51, 54, 55, 56, 80 and 81 at the National Reactor Testing Station, Idaho, OFR IDO–22045, by C.H. Chase, W.E. Teasdale, D.A. Ralston, and R.G. Jensen, 1964, 9 p. 56 figs. This report contains construction diagrams, geologists lithologic logs, and selected geophysical logs such as caliper, density, and natural gamma for the wells listed in the title.

IDO–22046–USGS Hydrology of subsurface waste disposal, National Reactor Testing Station, Idaho. Annual Progress Report 1963, OFR IDO–22046, by D.A. Morris, W.E. Teasdale and others, 1964, 97 p., 87 figs. As part of the effort to provide a regional description of the NRTS and surrounding areas, this report gives the results of a geohydrologic study at the NRTS and adjoining areas and also provides results of smaller site-specific studies. Results of the regional studies include a generalized Bouger gravity anomaly map, a preliminary aeromagnetic traverse flown at 500 ft, and aeromagnetic profiles along five different flight lines. The gravity and aeromagnetic data were used to formulate a conceptual model of the Little Lost River drainage at its mouth and to prepare maps depicting regional physiographic features, generalized stratigraphic cross sections at and north of the NRTS, and areas of intense regional faulting. The data also were used to delineate locations of a ground-water barrier, lineaments, and faults in basalt at the NRTS.

The sitewide ground-water sampling network in 1963 consisted of 21 wells and 10 surface-water sites (table 3). The report recommends adding wells USGS 33, and 3A, Atomic City, USGS 83, 9, and 8 to the sitewide network. In addition, 22 ground-water wells were sampled in the CCP (now INTEC) area (table 1), and 18 perched wells and 7 ground-water wells were sampled in the MTR-ETR (now TRA) area (table 2). The constituents analyzed generally included gamma radiation, sodium, and specific conductance; however, some wells were sampled for a complete suite of constituents.

The report also presents results of a comprehensive study at the NRF site for the first time. The study focused on the distribution of radioactivity in the subsurface associated with disposal to infiltration ponds ECF–A1W and S1W. Auger holes were installed near the ponds, and contour maps depicting the top of the first basalt layer and the tops of the overlying perched-water bodies were prepared. These results were displayed in figures 19–20, 23–25, and 29. Cross-sections through the ponds are shown in figures 21–22 and 27–28. In February 1963, radioactive contaminants were released unexpectedly to the MTR (now TRA) Retention Basin and Pond. The release was the largest up to that time, and movement of the waste through the regolith was monitored. Interpretation of natural gamma logs implied that the movement of waste was controlled by regolith geometry. Interpretation of gamma activity in water samples was less conclusive.

At the ICPP (now INTEC) Cutting Facility, the development of a perched-water body and the movement of low-level radioactive waste from a shallow disposal well was monitored by means of 27 auger holes drilled through the alluvium to the first basalt layer (see fig. 34). The formation of perched water and its movement was controlled by the configuration of the basalt layer. When the perched-water zone reached saturation, additional water was transmitted to the basalt. The geometry of the waste-disposal system also was documented. Also at the ICPP, a field study of dispersion using tritium indicated the weakness of tritium analytical methods. It was decided to start archiving water samples for analysis subsequent to improvement of the analytical methods.

To evaluate the disposal of radioactive gas to the subsurface several injection tests were done at the ICPP and TAN. Straight air, propane, or helium as a gas tracer were injected both above and below the water table.

The report provides a brief discussion of an experimental logging tool known as the Tracejector that measured velocity and direction of fluid flow in a borehole. Results were provided for two wells at the ICPP and one at the TRA. The method consisted of injecting I-131 into the borehole and tracking its movement with a gamma-ray logging tool. The geology and geography of the TAN-LOFT areas including a generalized surface geology map (fig. 53) and two cross-sections perpendicular to the Birch Creek drainage, one through the TAN (fig. 54) and the other through the PW wells in the mouth of the valley (fig. 55).

When well USGS 7 originally was drilled, perched water was encountered at 108 ft. Water-level studies in the TAN area reconfirmed that a narrow zone of low permeability stretches from the vicinity of well USGS 25 southeastward to the southern boundary of the TAN study area (fig. 56). Water levels in wells west of the zone responded to variation in underflow from Birch Creek, and those east of the zone responded to changes in flow from the Mud Lake area. Some specific-capacity data for wells in this area and other generalized hydrologic data are provided. In the TAN study area, a thin layer of fresher water at the water table was noted from specific-conductance data.

A detailed description of ground-water chemistry in the TAN-LOFT area, based on the work of Olmsted (IDO–22043–USGS), is given. A study of specific capacity was conducted at the NRTS and an areal view of the results was presented in figure 52. The maximum, minimum, and mean values of selected ions and physical parameters are provided in table 8; the chemical character of water samples and distribution of water types (A or B) identified by Olmsted is given in figure 58; and the distribution of sodium plus potassium, chloride, and temperature is shown in figures 59–61. The authors concluded that wells located away from contaminated areas reflect natural chemistry and that two zones of water chemistry are present: an eastern zone related to Mud Lake recharge and a western zone related to Birch Creek recharge. These types of waters generally were within the upper 50 to 200 ft of the saturated zone; the more dilute, fresher water occupied the upper 50 ft of the saturated zone. The temperature data in figure 61 indicates the presence of a plume of cooler Birch Creek water at the TAN-LOFT area trending perpendicular to the regional south to southwest direction of flow of the Snake River Plain aquifer. The report establishes a relation between specific conductance and the sum of ionized constituents for the TAN-LOFT area on the basis of 11 analytical results for samples from 8 wells: 0.543 times specific conductance equals the sum of ionized constituents. Guidelines on well

construction and an evaluation of four potential methods for disposing of waste at the TAN-LOFT area are provided. This report describes the configuration of the upper and lower perched zones at the M-ETR and the effects of the waste-pipeline break that was discovered in 1963. Figures 62–69 show water-level contours at various times during the repair of the break and the subsequent recovery of water levels in monitoring boreholes. Detailed descriptions of the effects of the break and its repair are provided. Efforts to collect basic records continued in 1963 and a substantial amount of drilling took place; 131 test holes totaling about 3,400 ft were drilled and 53 of these test holes totaling about 1,700 ft were cased with PVC. Solid-phase samples were collected and analyzed, and results were used to define characteristics of the regolith at several proposed facility sites: (1) LOFT site, 29 test holes were used to prepare an alluvium thickness map, 3 cross sections were prepared, and coefficients of permeability for 26 samples, specific gravities, dry unit weights, moisture equivalents, specific retentions, total porosities, specific yields, and grain-size distributions for 9 samples were determined; (2) SET site, 36 test holes were used to prepare an alluvium thickness map, 4 cross sections were prepared, and coefficients of permeability, specific gravities, dry unit weights, moisture equivalents, specific retentions, total porosities, specific yields, and grain-size distributions for 13 samples were determined; (3) A & M Test site, 4 test holes were used to prepare an alluvium thickness map; and (4) NTF site, boreholes were used to define the minimum thickness of the alluvium at 9 locations. To supplement the data previously collected, 53 other boreholes were drilled as follows: 5 at MTR, 25 at NRF, and 23 at CPP. Also, the geophysical-logging program, the water-quality monitoring program, and the water-level monitoring program all yielded significant amounts of data. Plans to conduct a deep-well project (INEL-1?) were mentioned in this report.

IDO–22047–USGS Hydrology of subsurface waste disposal, National Reactor Testing Station, Idaho, annual progress report 1964, OFR IDO–22047, by D.A. Morris, J.T. Barraclough, G.H. Chase, W.E. Teasdale, and R.G. Jensen, 1965, 147 p., 94 figs., 12 tables, appendix. Generally, this report presents USGS activities during 1964 with emphasis on geology, geochemistry, hydrology, and collection of basic records.

Geology.—Much of the geologic work presented was based on previously collected information supplemented with data collected in 1964. The comprehensive geologic study included

(1) an updated (from the 1955 map) and expanded surface geology map (fig. 1) prepared from an analysis of aerial photographs from the 1949 coverage and from field verification activities;

(2) an aeroradioactivity survey conducted in 1964 that was used to prepare maps showing basalt types (fig. 2) and relative basalt ages (fig. 3) at the NRTS and the surrounding area;

(3) definition of a physiographic depression that occupies most of the NRTS and Mud Lake area (fig. 4) and correlates well with the map showing structural features such as lineaments and faults (fig. 5) that were plotted using preliminary seismic studies and field mapping (examples of lineaments and faults are shown in figs. 6–7);

(4) depiction of the general tectonic characteristics of the NRTS and vicinity, including a map showing the relation of the Bannock Overthrust and related erosional features to the NRTS (fig. 8), a seismic profile across part of the mouth of the Birch Creek Valley (fig. 9), and a generalized cross section of the northern NRTS based on seismic, gravity, and aeromagnetic surveys and surface feature mapping (fig 10);

(5) preliminary plots of the results of gravity and aeromagnetic surveys (figs. 11 and 12), and refraction data between wells USGS 31 and 33 (fig. 13);

(6) identification of a zone of high permeability (fig. 14) that was used in conjunction with the gravity, aeromagnetic, and refraction data to infer a structural graben-type feature located in the southern to southeastern part of the NRTS;

(7) delineation by sector of anticipated subsurface geologic conditions at the NRTS (fig. 15), the estimated thickness of Cenozoic rocks in each sector (table 1), and the estimated depths and characteristics of the rocks in each sector (table 2);

(8) evaluation of the feasibility of using K-40/Ar-40 radiometric dating techniques (0.47 percent of basalt from 4 samples was K and of the K, 0.012 percent was K-40) by examining thin sections from several samples from the GIN site and the report by Roland Kologrivov (Isotopes, Inc., written commun. to authors, March 30, 1965), which also summarizes the mineralogy of the 20 samples;

(9) the methods of cutting, preparing, and studying cores and well cuttings, and textural and mineralogic descriptions of eight samples from the GIN site (authors conclude that Snake River Plain basalt weathering is generally proportional to depth);

(10) an experimental technique for evaluation of geophysical logs, which included direct comparison of measured bulk densities and gamma intensities of core- and drill-cutting materials and subsequent comparisons to density, natural gamma, and hole-diameter logs to improve geophysical-log interpretations (the gross gamma intensities of Tertiary silicic material, 0.00075–0.0035 mr/hr, were two to seven times larger than the average intensities for SRP basaltic rocks and the gamma intensities of mineralized fractures in basalt also were larger than those of the unweathered basalt);

(11) a summary of the seminar subjects in the May 1964 seminar at the NRTS entitled Features of Geologic Structure that was cosponsored by the USGS and the Atomic Energy Commission (AEC); and

(12) results of a trial collaboration among the AEC, the USGS, and the academic community wherein a graduate student [from the Association of Rocky Mountain Universities] was sponsored by the AEC and the USGS to study geologic and geophysical data at the NRTS and to develop new means for analyzing data. The trial collaboration established a precedent that is still being followed today; the principal conclusion of the student's study was that better results are derived from using a wide variety rather than just one of a few analytical tools.

Geochemistry.—The geochemistry work was based partly on the study of geophysical applications to describe chemistry changes in boreholes and analytical techniques to describe changes in aquifer chemistry related to waste disposal, both at selected facilities and sitewide. The geochemical studies included

(1) a description of the Tracejector study, which was begun in 1963 and continued in 1964 with the testing of 20 wells using the Tracejecter, specific conductance logs, and well-construction information to determine flow direction and velocity and their relation to borehole water chemistry (direction of vertical flow in most of the 20 wells studied was downward and examples of the method for wells USGS 28 and 4, Site 17, and MTR Test are shown in figures 19–21 and 23);

(2) use of water-resistivity-temperature geophysical logs in conjunction with specific conductance measurements to determine temporal changes in water chemistry. It was concluded that there were no short-term changes in chemistry, but that waste disposal could be identified at some locations; and,

(3) identification of changes in water quality and radioactivity during 1964 at the CCP (now INTEC) area, the TRA area, and sitewide by using sodium, specific conductance, gamma activity, and tritium.

Hydrology.—Hydrologic information presented includes detailed summaries of drilling and well preparation for the gas-injection test with information on well construction, well completion, and well records; a study describing the TRA waste-disposal ponds; a study describing the recompletion and testing of the TRA waste-disposal well; a study on the significance of specific capacity of wells; the effect of the Alaskan earthquake on water levels at the NRTS; and, a study of the regional hydrology at the NRTS.

Special studies.—Several special studies are summarized and include studies on thermo-conductivity, air-flow characteristics of basalt, relation of pond levels to water levels in the regional system and the perched-water systems, and field-scale dispersion.

Collection of basic records.—During 1964, records were collected and documented for the sitewide drilling program, the sitewide geophysical logging program, the sitewide sampling and water-level measurement program, water utilization, and the sitewide well modification program.

The report also provides a discussion on the future scope of USGS programs at the NRTS.

IDO–22048–USGS Hydrology of the National Reactor Testing Station, Idaho, annual progress report 1965, OFR IDO–22048, by J.T. Barraclough, W.E. Teasdale, and R.G. Jensen, 1967, 107 p. This report summarizes activities at the NRTS during 1965. Project summaries include those for collection of basic records (water-quality data, water-table data, stationwide test-drilling data, and Big Lost River discharge measurements); geohydrology (regional hydrology, the steep ground-water gradient and ground-water cascade near Howe, Idaho, TRA waste disposal, head differences and vertical borehole flow, and surface runoff at the NRTS with discussions of the geologic and hydrologic setting, discharge, storage capacity, infiltration rates, recharge and pressure transmission effects of recharge in the aquifer); geochemistry (changes in tritium along with publication of the first accurate plume map of tritium in the aquifer, changes in other radiometric elements, and changes in selected chemical constituents); and special studies (air flow in basalt, Tracejector surveys of the ICPP (now INTEC) area, research logging, gamma-ray spectra of rocks of the NRTS and vicinity, seismology of the NRTS, and interactions with the Association of Rocky Mountain Universities).

IDO–22049–USGS Hydrology of the National Reactor Testing Station, Idaho, 1966, OFR IDO–22049, by J.T. Barraclough, W.E. Teasdale, J.B. Robertson, and R.G. Jensen, 1967, 95 p. This report gives a summary of activities at the NRTS during 1966. Project summaries include regional hydrology (collection of water-table and water-quality data, well drilling, water-table map, utilization of ground water, and recharge from the Big Lost River); hydrology of waste disposal (determination of tritium background, disposal at TRA (including chromium content of ground water), disposal at the ICPP (including a tritium balance, the sodium content of ground water, and the use of tritium as a tracer and for determining ground-water flow velocities), and disposal at other facilities); and other hydrologic research (gas-injection tests at the Birch Creek Playa, air flow in basalt, fluoride in the SRPA, and zonal head differences in well USGS 4).

IDO–22050–USGS Stage-discharge relations on Big Lost River within National Reactor Testing Station, Idaho, OFR IDO–22050, by R.D. Lamke, 1969, 29 p. This report presents the results of a study to compute theoretical stage-discharge relations of 11 surface-water sites at the NRTS. Seven of the sites were associated with the Big Lost River diversion channel and spreading areas and four were associated with the terminal playas of the Big Lost River.

IDO–22051–USGS Behavior of Xenon-133 gas after injection underground: molecular diffusion, materials balance, and barometric pressure effects, OFR IDO–22051,

by J.B. Robertson, 1969, 37 p. This report presents the results of a field test to determine the feasibility of disposing of radioactive gas to the unsaturated zone. Xenon-133 was injected into the subsurface under the fine-grained sediments of Birch Creek Playa to evaluate whether the gas could be contained long enough for radioactive decay to render it harmless. A materials balance was conducted and resulted in good accountability for the total volume of gas. Also, the effects of diffusion to the atmosphere and of barometric pressure on fluxes were evaluated and found to be insignificant for the area tested. The overall conclusion was that underground disposal of gases is feasible for the conditions studied.

IDO–22052–USGS Probability of exceeding capacity of flood-control system at the Idaho National Reactor Testing Station, Idaho, OFR IDO–22052, by P.H. Carrigan, Jr., 1972, 102 p. This report describes a mathematical model for estimating the probability of exceeding the capacity of the flood-control system at the NRTS for floods of varying recurrence intervals. The model uses streamflow records from the gaging station Big Lost River below Mackay Reservoir near Mackay, Idaho. The report also presents discussions of five alternate methods for providing additional flood control at the NRTS.

IDO–22053–USGS The influence of liquid waste disposal on the geochemistry of water at the National Reactor Testing Station, Idaho, 1952–70, OFR IDO–22053, by J.B. Robertson, Robert Schoen, and J.T. Barraclough, 1974, 231 p. This report presents the first comprehensive evaluation of the effects of waste disposal on the environment at the NRTS (from 1952 to 1970) in a format that provided the framework for the hydrologic condition reports. The report presents: background concentrations for several constituents, which are referenced still today in the hydrologic conditions reports; a comparison of maps of constituent plumes through time; a comprehensive look at the geochemical environment at the site, including the geology and an analysis of saturation indices of water samples with respect to the Snake River Plain aquifer minerals; an identification of reactions taking place in the recharge areas; chemical analyses of water in many wells perceived as unaffected by wastes (table 3); depth of perched zones encountered while drilling several aquifer wells at the ICPP (now INTEC) (table 12); a comprehensive list of all Snake River Plain monitoring wells at the NRTS and well completion dates (table 14); chemical analyses for 207 ground-water samples (Appendix B)—the author lists several reasons why accuracy of the analyses were poor; and a water budget for the ICPP (Appendix C).

IDO–22054–USGS Digital modeling of radioactive and chemical waste transport in the Snake River Plain aquifer at the National Reactor Testing Station, Idaho, OFR IDO–22054, by J.B. Robertson, 1974, 41 p. This report presents the results, applications, and limitations of the digital computer model used to predict chemical transport in the Snake River Plain aquifer at the NRTS. This modeling effort was one of the pioneering efforts to use a mathematical computer model to predict behavior of waste migration. Model-projected maps of chloride, tritium, and strontium-90 plumes for the system in 1980 and 2000 and criteria used for the models are presented. Despite the changing waste-disposal conditions, the model predicted the transport of contaminants in the flow system reasonably well.

IDO–22055–USGS Hydrologic data for the Idaho National Engineering Laboratory site, Idaho, 1971 to 1973, OFR 75–318, by J.T. Barraclough, and R.G. Jensen, 1976, 52 p. This report is the second in a series of reviews of USGS hydrologic data collected at the INEL. The report presents the number and type of analyses for 1971, 1972, and 1973, and constituent plume maps for tritium, strontium-90, sodium, chloride, and specific conductance. All the plume maps cover similar areas. Large water-level rises in several wells at the INEL were attributed to the influence of high flows in the Big Lost River. Water levels increase from as little as 0 ft in the northern part of the site to 16.4 ft in the western part from 1962 to 1972. The largest tritium concentration in the aquifer was 146 pCi/L in well USGS 38.

IDO–22056–USGS Hydrology of the solid waste burial ground, as related to the potential migration of radionuclides, Idaho National Engineering Laboratory, *with a section on* Drilling and sample analysis by L.G. Saindon: OFR 76–471, by J.T. Barraclough, J.B. Robertson, and V.J. Janzer, 1976, 183 p. This is the first published comprehensive report of the hydrology of a radioactive waste burial site in the United States. The report describes the results of a study done during 1970–74 to evaluate the geohydrologic and geochemical controls on subsurface migration of radionuclides from pits and trenches at the RWMC and to determine the existence and extent of radionuclide migration from the burial ground. Another objective was to drill wells to monitor the water. About 1,700 sediment, rock, and water samples were collected from 10 observation wells. Many results of various analyses are presented. The report also presents well-completion data for wells USGS 87, 88, 89, 90, and 92 (table 1) and drilling-record data for coreholes USGS 91, 93, 94, 95, and 96 (table A-II). Radionuclides were detected in about 10 percent of the samples from the 110- and 240-ft sedimentary layers.

IDO–22057–USGS Numerical modeling of subsurface radioactive solute transport from waste-seepage ponds at the Idaho National Engineering Laboratory, OFR 76–717, by J.B. Robertson, 1977, 68 p. This report presents a three-segment numerical model to simulate flow and transport of chemical and radionuclide constituents in perched ground-water zones beneath the TRA. The model included the effects of convection, hydrodynamic dispersion, radioactive decay, and adsorption, and model results indicated that tritium and chloride enter the aquifer and will continue to enter the aquifer as long as they are discharged to the ponds. Model analysis suggests that the more easily sorbed solutes, such as cesium-137 and strontium-90, will not reach the aquifer unless conditions change.

IDO–22058–USGS Probable hydrologic effects of a hypothetical failure of Mackay Dam on the Big Lost River Valley from Mackay, Idaho, to the Idaho National Engineering Laboratory, WRI 79–99, by Leroy Druffel, G.J., Stiltner, and T.N. Keefer, 1979, 47 p. The purpose of this report was to calculate and route the flood wave from Mackay Dam downstream to the INEL that would result from a hypothetical failure of Mackay Dam. Both full and 50-percent partial breach was investigated. The method of characteristics was used to propagate the hypothetical shock wave after the dam failure and the linear implicit finite-difference solution was used to route the hypothetical flood wave after the shock wave dissipated. Time of travel of flood wave, duration of flooding, and magnitude of flood was determined for eight sites from Mackay Dam through the diversion at the INEL. At 4.2 km above the diversion, peak discharges of 1,502 and 1,275 m^3/sec and peak flood elevations of 1,550.3 and 1,550.2 meters were calculated for full and partial breaches, respectively. Lack of information on floodplain geometry prevented calculation of results downstream from the diversion.

IDO–22059–USGS A wind-powered, ground-water monitoring installation at a radioactive waste management site in Idaho, WRI OFR 81–493, by J.C. Bagby, G.E. Ghering, R.G. Jensen and J.T. Barraclough, 1981, 28 p. This report describes the initial monitoring systems installed in wells USGS 87–90 at the RWMC to measure water levels and collect samples. Submersible pumps were installed and transducer probes were put down the measuring lines to get constant water-level readings. Shelters were built at each well (USGS 87 still has its shelter) and a windmill-battery system was designed and installed at each site to power the water-level recorders.

IDO–22060–USGS Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho, emphasis: 1974–78, WRI OFR 81–526, by J.T. Barraclough, B.D. Lewis, and R.G. Jensen, 1981, 77 p. This is the third report in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer and perched-water zones. This report covered the period 1974–78. Water levels declined during this time period by as much as 10 ft near the RWMC and north of the NRF. Water-level hydrographs are presented for 21 aquifer wells and 4 perched-water wells. The perched-water zone contains tritium, chromium-51, cobalt-60, strontium-90, and several nonradioactive ions. In 1978, the largest tritium concentration in the aquifer was 204,000 pCi/L in well USGS 67 and the tritium plume covered about 28 mi2. Iodine-129 was first analyzed as part of the routine water-quality sampling program starting in May 1976; an iodine-129 plume map for 1977 was presented. Plutonium was detected in three samples from well USGS 47.

IDO–22061–USGS Organic solutes in ground water at the Idaho National Engineering Laboratory, WRI 82–15, by J.A. Leenheer, and J.C. Bagby, March 1982, 39 p. This report describes an August 1980 reconnaissance survey of organic solutes in perched-water and aquifer wells. Water from 77 wells and 4 point sources were sampled for dissolved organic carbon; water from 4 wells and several point sources were sampled for selected insecticides and herbicides; and water from 14 wells and 4 point sources were sampled for volatile and semivolatile organic compounds. Dissolved organic carbon (DOC) was detected in most samples, but concentrations were not considered harmful. No significant concentrations of other compounds were detected, so no additional monitoring of these wells was done. Methods of collection and sample depths for wells sampled are given in table 1 along with DOC data—mostly from thief samples, which jeopardized the quality of the samples.

IDO–22062–USGS Evaluation of a predictive ground-water solute-transport model at the Idaho National Engineering Laboratory, Idaho, WRI 82–25, by B.D. Lewis and F.J. Goldstein, 1982, 71 p. This report evaluates the digital solute-transport modeling study (IDO–22054), which predicted the extent of constituent plumes for 1980. Eight wells were drilled in the summer of 1980 (USGS 103–110) to fill gaps in the INEL hydrogeologic database, delineate the leading edge of the waste plumes, and monitor first arrivals at the boundary of the INEL. A complete suite of information is given for these eight wells. The extent of the waste plumes was 2 to 3 mi upgradient from the southern boundary. The model projected further movement of the plumes owing to conservative worst-case assumptions in the input and inaccurate approximations of subsequent waste discharge and aquifer recharge.

IDO–22063–USGS Subsurface information from eight wells drilled at the Idaho National Engineering Laboratory, southeastern Idaho, OFR 82–644, by F.J. Goldstein and W.D. Weight, 1982, 29 p. From 1969 to 1974, six wells (USGS 97–101 and RWMC Production) were drilled, and two wells (USGS 30 and Highway 1) were deepened and piezometers were installed. This report describes construction of these wells and summarizes information gained from the drilling program about the subsurface geology and hydrology. Table 1 lists well information for the eight wells. Completion diagrams, lithology diagrams, and geophysical logs are given for each well.

IDO–22064–USGS Ground-water site inventory data for selected wells on or near the Idaho National Engineering Laboratory, 1949 through 1982, OFR 84–231, by J.C. Bagby, L.J. White, and R.G. Jensen, 1984, 353 p. This report presents a compilation of all ground-water-site inventory data for wells at the INEL through 1982. Well-construction and well-completion information is given for all the wells.

IDO–22065–USGS Water-level data for selected wells on or near the Idaho National Engineering Laboratory, 1949 through 1982, OFR 84–239, by J.T. Barraclough, J.C. Bagby, L.J. White, and R.G. Jensen, 1984, 343 p. This report presents a compilation of all the water-level data from wells at and near the INEL from 1949 through 1982. The data are for wells that penetrate the Snake River Plain aquifer at or near the INEL.

IDO–22066–USGS Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho: 1979–81 update,

OFR 84–230, (also published as ATLAS HA–674) by B.D. Lewis and R.G. Jensen, 1984, 65 p. This is the fourth in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer and perched-water zones at the INEL. This report covered the period 1979–81. Water levels continued to decline in the aquifer; net declines from the 1972 high to July 1981 are shown in figure 8. Tritium in the aquifer covered about 42 mi^2 and the largest concentration was 156,000 pCi/L. The iodine-129 concentration plume increased in size presumably because of an increased sensitivity in the measurement process. During the summer of 1980, detectable plutonium-238 was found in well 40. Plutonium detections also were found in USGS 90 at the RWMC, however, the measurements were not reproducible.

DOE/ID–22067 Description and hydrogeologic implications of cored sedimentary material from the 1975 drilling program at the Radioactive Waste Management Complex, Idaho, WRIR 84–4071, by C.T. Rightmire, 1984, 33 p. This report presents data on particle-size distribution, bulk mineralogy, clay mineralogy, cation-exchange capacity, and carbonate content from sedimentary interbeds and fracture fill from cores from USGS 93A and 96B. A description of the core, lithologic and geophysical logs, and six thin-section analyses also are presented.

DOE/ID–22068 Water-quality data for selected wells on or near the Idaho National Engineering Laboratory, 1949 through 1982, OFR–84–714, by J.C. Bagby, L.J. White, and R.J. Jensen, 1985, 800 p. This report presents water-quality data for samples collected from 140 wells from 1949 to 1982. The report presents types of samples collected and identification of laboratories that analyzed the samples.

DOE/ID–22069 Aqueous radioactive- and industrial-waste disposal at the Idaho National Engineering Laboratory through 1982, OFR 85–636, by B.D. Lewis, J.M. Eagleton, and R.G. Jensen, 1985, 77 p. This report summarizes in tabular form the information recorded by site contractors at each facility on the amounts of radioactive and chemical aqueous waste disposal from 1961 through 1982.

IDO–22070–USGS Hydraulic properties of rock units and chemical quality of Water for INEL-1—a 10,365-ft deep hole drilled at the Idaho National Engineering Laboratory, Idaho, WRIR 86–4020, by L.J. Mann, 1986, 23 p. This report confirms the existence of about 8,200 ft of tuffaceous and rhyolitic volcanic rocks underlying about 2,200 ft of basaltic rocks interbedded with sediments at INEL-1—an exploratory geothermal test hole. The report presents (1) a generalized lithologic log, (2) transmissivities and hydraulic conductivities determined from aquifer tests at four intervals, (3) hydraulic head data with depth, (4) a water-temperature profile for the test hole, (5) water-chemistry data from four intervals, and (5) hydrochemical-facies data with depth.

DOE/ID–22071 Capacity of the diversion channel below the flood-control dam on the Big Lost River at the Idaho National Engineering Laboratory, WRIR–86–4204, by C.M. Bennett, 1986, 25 p. This report presents the findings of a study to determine the capacity of the Big Lost River diversion channel at various stage-discharge conditions. The capacity of the diversion channel plus two overflow swales was determined to be 9,300 ft^3/s, which equates to a stage elevation of 5,065.5 ft at the downstream edge of the diversion dam. This elevation was the same elevation as that of the dike along the diversion channel and indicated that a sustained flow at 9,300 ft^3/s likely would cause the dike to fail.

DOE/ID–22072 Geologic data collected and analytical procedures used during a geochemical investigation of the unsaturated zone, Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, OFR 87–246, by C.T. Rightmire and B.D. Lewis, 1987, 83 p. This report describes cored material and subpit sedimentary samples and documents the sample preparation and analytical techniques used to characterize the geochemical environment of the unsaturated zone at the RWMC. This data was compiled to aid in the development of a conceptual model of the hydrogeochemical environment of the shallow unsaturated zone and to determine how changes in that environment could affect the mobility and migration of waste radionuclides buried in the subsurface disposal area of the RWMC. Core-sample descriptions and some thin-section and scanning-electron-microscopy analyses are given for eight cores at the RWMC.

DOE/ID–22073 Hydrogeology and geochemistry of the unsaturated zone, Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, WRIR 87–4198, by C.T. Rightmire and B.D. Lewis, 1987, 89 p. This report describes results of a study to aid in the development of a conceptual model of the hydrogeochemical environment of the shallow unsaturated zone and to determine how changes in that environment could affect the mobility and migration of waste radionuclides buried in the subsurface disposal area of the RWMC. Stable isotope and chemical data suggested that the perched water observed beneath the RWMC is not the result of vertical infiltration but results from the lateral flow of water that infiltrated through the diversion ponds. Data on particle-size, mineralogy, carbonate content, and cation-exchange capacity are presented for samples at the RWMC. The stratigraphy and some isotope and water-chemistry data also are presented.

DOE/ID–22074 Purgeable organic compounds in ground water at the Idaho National Engineering Laboratory, Idaho, OFR 87–766, by L.J. Mann and L.L. Knobel, 1987, 23 p. This is the first in a series of four data reports that presents analytical results for purgeable organic compounds in water samples from the INEL and vicinity. The report describes reconnaissance-level sampling for 36 purgeable organic compounds from 81 aquifer wells and 1 perched-water well that was done during June to November 1987. All of the aquifer wells sampled had submersible pumps. Twelve compounds were detected in samples. The TAN Disposal (now TAN/TSF Injection) well contained 35,000 µg/L of trichloroethylene and 22,000 µg/L of 1,2-trans-dichloroethylene. Several compounds were detected in water from well USGS 92. Duplicate samples from 39 wells were sent to the EG&G Environmental Chemistry Laboratory.

DOE/ID–22075 Concentrations of nine trace metals in ground water at the Idaho National Engineering Laboratory, Idaho, OFR 88–332, by L.J. Mann and L.L. Knobel, May 1988, 17 p. This report summarizes reconnaissance-level sampling for nine trace elements from 81 aquifer wells and 1 perched-water well that was done during June to November 1987. Samples were analyzed for arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, and silver. Chromium concentrations in water from two wells, USGS 65 and 89, exceeded maximum contaminant levels (MCL's). Concentrations of all other trace metals were smaller than established MCL's.

DOE/ID–22076 Iodine-129 in the Snake River Plain aquifer at the Idaho National Engineering Laboratory, Idaho, WRIR 88–4165, by L.J. Mann, E.W. Chew, J.S. Morton, and R.B. Randolph, 1988, 27 p. This report presents concentrations of iodine-129 (I-129) in water samples from 35 wells near the ICPP (now INTEC) collected in August 1986. This sample-collection round of 1986 was the third round of sampling for I-129 and followed sampling rounds of 1977 and 1981. The 1986 concentrations were markedly smaller than those of earlier rounds: the maximum concentration in 1977 was 27±1 pCi/L; the maximum in 1981 was 41±2 pCi/L; and the maximum in 1986 was 3.6±04 pCi/L. The decrease was attributed to three factors: decrease in disposal rates, change in disposal methods in 1984, and increased dilution in the aquifer due to increased recharge from the Big Lost River. Concentrations of I-129 in all samples collected in 1977, 1981 and 1986 were presented in table 1. Plume maps for the 3 years also were presented.

DOE/ID–22077 Radionuclides in ground water at the Idaho National Engineering Laboratory, Idaho, OFR 88–731, by L.L. Knobel and L.J. Mann, 1988, 37 p. This report presents results for water samples analyzed for tritium, strontium-90, plutonium-238, plutonium-239, -240 (undivided), americium-241, cesium-137, cobalt-60, and potassium-40. The samples were collected from 80 aquifer wells and 1 perched-water well during September to November 1987. Table 1 gives the year of publication and authors of the first USGS reports describing various radionuclides at the INEL. The largest tritium concentration was in water from well USGS 65 and was 80,600±1,500 pCi/L. Strontium-90 concentrations in water from two wells near the RWMC (USGS 87 and 89) were larger than the reporting level. The largest concentration of strontium-90 was in the TAN Disposal (now TAN/TSF Injection) well and was 1,930±50 pCi/L. Water from the TAN Disposal well contained reportable concentrations of plutonium and americium. The concentration of plutonium-238 in the initial water sample from CFA-1 was above the reporting level, but the concentration in a resample of the water was less than the reporting level. Water from the TAN disposal well contained reportable concentrations of cesium-137 and cobalt-60; water from a resample did not contain reportable concentrations of cobalt-60.

DOE/ID–22078 Hydrologic conditions at the Idaho National Engineering Laboratory, 1982 to 1985, WRIR 89–4008, by J.R. Pittman, R.G. Jensen, and P.R. Fischer, 1988, 73 p. This is the fifth in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer and perched-water zones at the INEL. This report covered the period 1982–85. Concentrations of tritium began to decrease in the aquifer, as much as 80 pCi/L near the ICPP (now INTEC); however, tritium was discovered in water from wells at the southern boundary for the first time. The largest tritium concentration was in well 65 at 93.4±2.0 pCi/L. Concentrations of strontium-90, sodium, chloride, and nitrate in water from wells near the ICPP also decreased from 1981 concentrations. Water levels rose as much as 12 ft in the area north of NRF from 1981 to 1985. Velocity of water movement at INEL, calculated on the basis of first arrivals of tritium, was 4 to 5 ft/day. Plutonium isotopes were detected in several samples from well USGS 40 during 1982–85. Plutonium-238 was detected in one sample from well USGS 47. Sulfate data were described.

DOE/ID–22079 Hydrological and meteorological data for an unsaturated zone study near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho—1985–86, OFR 89–74, by J.R. Pittman, 1989, 175 p. This report is the first in a series of five data reports that provide information for estimating the potential for migration of radionuclides in the unsaturated zone at the RWMC. The report presents soil-temperature and soil-water measurements taken every 12 hours during 1985 and 1986 using equipment installed in two test trenches in the surficial sediment adjacent to the RWMC. These data were collected to determine reliable estimates of the amount of water that infiltrates the surficial sediment and eventually recharges the aquifer and to aid in the calibration of a numerical model to determine the potential for migration of radionuclides in the unsaturated zone. The report describes the design of and instrumentation used in the test trenches. Soil temperatures in undisturbed soils at the test trench ranged from -1.7 to 22.2 °C. Soil-water potentials in the undisturbed soils at the test trench ranged from the sensor detection limit of -1.0 to about -20 bars. There was little or no change in soil temperatures or soil-water potentials at depths below 5m. The annual precipitation at the RWMC in 1986 was 240 mm.

DOE/ID–22080 Stratigraphy of the unsaturated zone at the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, WRIR–89–4065, by S.R. Anderson and B.D. Lewis, 1989, 54 p. This report describes the stratigraphic framework of the unsaturated zone in the RWMC area on the basis of geologic and geophysical data collected from June 1971 to September 1988. Ten basalt-flow groups and seven major sedimentary interbeds below the RWMC were defined. The thickness and altitude of the basalt flows and sedimentary interbeds also were provided.

DOE/ID–22081 Mineralogy and grain size of surficial sediment from the Big Lost River drainage and vicinity, with chemical and physical characteristics of geologic materials from selected sites at the Idaho National Engineering Laboratory, Idaho, OFR–89–384, by R.C. Bartholomay, L.L. Knobel, and L.C. Davis, 1989, 74 p. This report presents mineralogy and grain size data from 11 sites from the Big Lost River channel, 5 overbank deposits, 6 sites from the spreading areas, 7 sites from the Big Lost River sinks and playas, 1 site from the Little Lost River sinks, and 5 sites from small, isolated basins at different locations around the INEL. The report also presents mineralogy data from sedimentary interbeds, basalts, and fracture-infill material from cores from eight wells. In addition, this report also presents previously-published USGS data (before 1989) on cation-exchange capacity, bulk chemistry, specific gravity, mineralogy, and grain size.

DOE/ID–22082 Mineralogy and grain size of surficial sediment from the Little Lost River and Birch Creek drainages, Idaho National Engineering Laboratory, Idaho, OFR–89–385, by R.C. Bartholomay and L.L. Knobel, 1989, 19 p. This report presents mineralogy and grain-size data from five sites from the Little Lost River channel and two overbank deposits and five sites from the Birch Creek channel and one overbank deposit. Mineralogy data indicated that Birch Creek contains larger mean percentages of quartz and calcite and smaller mean percentages of total feldspar and dolomite than the Little Lost River deposits contain. Illite was the predominant clay in both drainages, but the Little Lost River deposits contained more smectite, mixed-layer clays, and kaolinite than the Birch Creek deposits contained.

DOE/ID–22083 Evaluation of field sampling and preservation methods for strontium-90 in ground water at the Idaho National Engineering Laboratory, Idaho, WRIR 89–4146, by L.D. Cecil, L.L. Knobel, S.J. Wegner, and L.L. Moore, 1989, 24 p. This study was done as part of the quality-assurance program to evaluate the effect of filtration and preservation methods on strontium-90 concentrations in ground water. Water samples from four wells were filtered through either a 0.45 or 0.1 μm membrane filter; unfiltered samples also were collected. Two sets of filtered and two sets of unfiltered water samples were collected at each well. One set of water samples was preserved in the field to an approximate 2-percent solution with hydrochloric acid and the other set of samples was not acidified. Descriptive statistics were used to determine reproducibility between the analytical results of the different filtration and preservation methods used. The results suggested that within-laboratory reproducibility of results for strontium-90 in ground water at the INEL is not significantly affected by changes in filtration and preservation methods used for sample collection.

DOE/ID–22084 Tritium concentrations in flow from selected springs that discharge to the Snake River, Twin Falls-Hagerman Area, Idaho, WRIR 89–4156, by L.J. Mann, 1989, 20 p. This study was done to determine whether the disposal of tritium in wastewater at the INEL had a measurable effect on tritium concentrations in springflow discharged to the Snake River in the area between Twin Falls and Hagerman, Idaho. Samples were collected from 17 springs in November 1988 and from 19 springs in March 1989. Analyses showed that the tritium concentrations in November 1988 were less than the minimum detectable concentration of about 0.5 pCi/mL and the concentrations in March 1989 were less than about 0.2 pCi/mL. Results given in this report indicated that waste disposal at the INEL had no measurable effect on tritium concentrations in the springflow.

DOE/ID–22085 Selected quality-assurance data for water samples collected by the U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho, 1980 to 1988, WRIR 89–4168, by S.J. Wegner, 1989, 91 p. This report compares analytical results of multiple water samples collected during 1980–88 from 115 wells and 3 surface-water sites as part of the quality-assurance program at the INEL. Samples were analyzed by six separate laboratories involved in the water-quality monitoring program. Descriptive statistics were used to evaluate the data for agreement among results for the following constituents and properties: tritium, plutonium-238, plutonium-239,-240, strontium-90, americium-241, cesium-137, total dissolved chromium, sodium, chloride, nitrate, and specific conductance. The laboratory results analyzed with the descriptive statistics showed a median agreement of 95 percent among all usable data pairs.

DOE/ID–22086 Hydrological, meteorological, and geohydrological data for an unsaturated zone study near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho—1987, OFR 90–114, by L.C. Davis and J.R. Pittman, 1990, 208 p. This report is the second in a series of five data reports that provide information for estimating the potential for migration of radionuclides in the unsaturated zone at the RWMC. The report presents soil-temperature and soil-water measurements recorded hourly and averaged every 12 hours during 1987 by equipment installed in test trenches in the surficial sediment adjacent to the RWMC. These and other data were collected to determine reliable estimates of the amount of water that infiltrates the surficial sediment and eventually recharges the aquifer and to aid in the calibration of a numerical model to determine the potential for migration of radionuclides in the unsaturated zone. Other data collected included meteorological data such as incoming and emitted long-wave radiation, incoming and reflected short-wave radiation, air temperature, relative humidity, windspeed, wind direction, and precipitation. Grain-size distribution, carbonate content, color, particle roundness and sphericity, and mineralogic and clastic constituents were determined for selected sediment samples.

DOE/ID–22087 Radionuclides, metals, and organic compounds in water, eastern part of A & B irrigation district, Minidoka County, Idaho, OFR 90–191, by L.J. Mann and L.L. Knobel, 1990, 36 p. This data-collection study was done in response to public concern that radioactive and chemical

wastes disposed to the Snake River Plain aquifer at the INEL had migrated to an area centered in the eastern part of the A & B Irrigation District. Samples were collected from 12 ground-water and 3 irrigation-wastewater sites and analyzed for tritium, gross alpha- and beta-particle radioactivity, total uranium, radium, radon-222, strontium-90, gross gamma radioactivity, trace metals, purgeable organic compounds, nutrients, and pesticides.

DOE/ID–22088 Digitized geophysical logs for selected wells on or near the Idaho National Engineering Laboratory, Idaho, OFR 90–366, by R.C. Bartholomay, 1990, 347 p. This report presents selected digitized geophysical logs from all wells logged before August 1989. The logs were digitized, processed, and stored on floppy disks. The types of logs available and the number of each digitized log are listed in a table for wells on or near the INEL. Selected neutron, gamma-gamma, gamma, and caliper logs are presented.

DOE/ID–22089 Purgeable organic compounds in water at or near the Idaho National Engineering Laboratory, Idaho, 1988 and 1989, OFR 90–367, by L.J. Mann, 1990, 17 p. This is the second of a series of four data reports that presents analytical results for purgeable organic compounds in water samples from the INEL and vicinity. Ground-water samples from 38 wells were analyzed for 36 purgeable organic compounds. Samples from 22 wells contained detectable concentrations of at least 1 of 19 purgeable organic compounds. Water from four wells at and near the TAN contained from 44 to 29,000 μg/L of trichloroethylene.

DOE/ID–22090 Tritium in ground water at the Idaho National Engineering Laboratory, Idaho, WRIR 90–4090, by L.J. Mann and L.D. Cecil, 1990, 35 p. This report describes the distribution and concentration of tritium in ground water and the factors that affected the migration of tritium in the Snake River Plain aquifer through 1988. The average concentration of tritium in water from 26 selected wells decreased from 250 pCi/mL in 1961 to 18 pCi/mL in 1988. The maximum concentration was 844±5 pCi/mL in 1961 and 61.6±1.1 pCi/mL in 1988. Four major causes of the decrease in the tritium concentrations were (1) a decrease in disposal rates, (2) a change in waste disposal practices, (3) radioactive decay, and (4) dilution from recharge. Tritium-disposal data and distribution maps for 1961, 1970, 1977, 1985, and 1988 are presented.

DOE/ID–22091 Streamflow losses and ground-water level changes along the Big Lost River at the Idaho National Engineering Laboratory, Idaho, WRIR 90–4067, by C.M. Bennett, 1990, 49 p. The purpose of this report was to define infiltration of water through the streambed of the Big Lost River and availability of water for recharge from playas and spreading areas. Compilation of streamflow data, analyses of seepage-run data, and comparison of streamflow-infiltration losses with ground-water levels are presented. Infiltration losses ranged from 1 to 28 ((ft^3/s)/ mi) and were largest during high stages. Water levels near the RWMC and north of the NRF were substantially affected by recharge from the Big Lost River.

DOE/ID–22092 Mineralogical correlation of surficial sediment from area drainages with selected sedimentary interbeds at the Idaho National Engineering Laboratory, Idaho, WRIR 90–4147, by R.C. Bartholomay, 1990, 18 p. This report describes the results of a mineralogical correlation between surficial sediment from the Big Lost River, Little Lost River, and Birch Creek drainage basins and sedimentary deposits interbedded with basalt flows underlying the INEL. The correlations were based on mineralogical data from 43 surficial-sediment samples and 105 sedimentary-interbed samples. Mineralogical data indicated that surficial-sediment samples from the Big Lost River drainage contained a larger amount of feldspar and pyroxene and a smaller amount of calcite and dolomite than samples from the Little Lost River and Birch Creek. Mineralogical data from sedimentary interbeds at the RWMC, the TRA, and the ICPP (now INTEC) correlated with the mineralogy of surficial sediment from the present-day Big Lost River drainage. Data from a sedimentary interbed at TAN correlated with data for surficial sediment of the present-day Birch Creek drainage.

DOE/ID–22093 Nutrients, pesticides, surfactants, and trace metals in ground water from the Howe and Mud Lake areas upgradient from the Idaho National Engineering Laboratory, Idaho, OFR 90–565, by D.D. Edwards, R.C. Bartholomay, and C.M. Bennett, 1990, 19 p. This report presents results of a reconnaissance-level sampling for selected nutrients, pesticides, and surfactants in ground water upgradient from the INEL during June 1989. Water samples were collected from eight irrigation wells, five domestic or livestock wells, and two irrigation canals. Three of the samples also were analyzed for arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

DOE/ID–22094 Background concentrations of selected radionuclides, organic compounds, and chemical constituents in ground water in the vicinity of the Idaho National Engineering Laboratory, WRIR 91–4015, by B.R. Orr, L.D. Cecil, and L.L. Knobel, 1991, 52 p. This report documents background concentrations of selected radionuclides and chemical constituents in ground water in the vicinity of the INEL. The background concentrations were compiled from chemical analyses of ground-water samples collected from wells at the INEL, in the Snake River Plain, and throughout the State of Idaho. Background concentration ranges are given for transuranic elements, tritium, strontium-90, iodine-129, gross alpha and beta-particle radioactivity, gamma radioactivity, purgeable organic compounds, pesticides, arsenic, chromium, barium, lead, mercury, cadmium, selenium, silver, fluoride, and nitrate.

DOE/ID–22095 Stratigraphy of the unsaturated zone and uppermost part of the Snake River Plain aquifer at the Idaho Chemical Processing Plant and Test Reactors area, Idaho National Engineering Laboratory, Idaho, WRIR 91–4010, by S.R. Anderson, 1991, 71 p. This report examines the stratigraphy in the upper 700 ft of the unsaturated zone and aquifer at the ICPP (now INTEC) and the TRA. The stratigraphy was determined using geophysical logs, lithologic

logs, and well cores. The wells examined showed a sequence of 23 basalt-flow groups and 15 to 20 sedimentary interbeds. One well examined may penetrate the effective base of the aquifer about 1,200 ft below land surface in this area. Thickness and altitude of the various stratigraphic units are presented.

DOE/ID–22096 Hydrologic conditions and distribution of selected chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1986 to 1988, WRIR 91–4047, by B.R. Orr and L.D. Cecil, 1991, 56 p. This is the sixth in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer. This report covered the period 1986–88. In addition, this series of reports previously had contained information on the effects of waste disposal on the distribution of constituents in perched-water zones at the INEL. The information on perched-water zones at the INEL currently is published in a new series of reports starting with DOE/ID-22100. During this 3-year period, water levels were highest during 1987 and were declining at the end of 1988, tritium concentrations continued to decrease (as much as 39 pCi/mL), and strontium-90 concentrations also decreased. The decreased radionuclide concentrations were attributed to reduced rates of radionuclide-waste disposal, sorption processes, radioactive decay, dilution from recharge, and changes in waste-disposal practices. Concentrations of plutonium and americium isotopes, cobalt-60, and cesium-137 were greater than the reporting level in water from the TAN Disposal well. Selected samples from wells USGS 40 and CFA-1 contained plutonium isotopes.

DOE/ID–22097 Transmissivity of the Snake River Plain aquifer at the Idaho National Engineering Laboratory, Idaho, WRIR 91–4058, by D.J. Ackerman, 1991, 35 p. This report presents specific-capacity and aquifer data from 183 single-well tests at 94 wells in the Snake River Plain aquifer that were used to estimate values of transmissivity. Transmissivity estimates ranged from 1.1 to 7.6×10^5 ft^2/day, nearly 6 orders of magnitude, for the upper 200 ft of the aquifer. Information on the types of openings of all wells tested is given in a table.

DOE/ID–22098 Radionuclides, chemical constituents, and organic compounds in water from designated wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1989, OFR 91–232, by S.J. Wegner and L.J. Campbell, 1991, 49 p. This report presents the results of the first year of a long-term study to monitor the water quality of the Snake River Plain aquifer in the area between the INEL and Hagerman. Water samples from 55 sites were collected and analyzed for tritium, strontium-90, radon-222, gross alpha, beta, and gamma, total uranium, radium, eight trace elements, nutrients, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22099 Transmissivity of perched aquifers at the Idaho National Engineering Laboratory, Idaho, WRIR 91–4114, by D.J. Ackerman, 1991, 27 p. This report presents aquifer and specific-capacity test data from 43 single-well tests at 22 wells in perched aquifers at the INEL. The report also presents estimates of transmissivity, which ranged from 1.0 to 15,000 ft^2/day, more than 4 orders of magnitude. Information on opening type is given for all wells tested.

DOE/ID–22100 Formation of perched ground-water zones and concentrations of selected chemical constituents in water, Idaho National Engineering Laboratory, Idaho 1986–88, WRIR 91–4166, by L.D. Cecil, B.R. Orr, T. Norton, and S.R. Anderson, 1991, 53 p. This is the first in a series of reports covering the effects of waste disposal on the distribution of constituents in perched-water zones at the INEL. The information contained in this series of reports was previously published in the series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer and perched-water zones at the INEL. For additional information see reports DOE/ID-22078 and DOE/ID-22096. This report describes the lithologic features that control the formation of the perched-water zones at the INEL and presents an analysis of water-level and water-quality data from samples collected during 1986–88. Maximum tritium concentrations in the deep perched water at the TRA decreased from 1,770±30 pCi/L in 1985 to 948±14 pCi/L in 1988. Chromium-51, cobalt-60, and cesium-137 were not detected in deep perched zones at the TRA. The maximum concentration of total dissolved chromium in deep perched water was 170±20 mg/L in 1988. Six wells, PW-1–6 were constructed in 1986 to monitor water at the ICPP (now INTEC). During 1987–88, water samples from these wells contained detectable concentrations of several radiochemical and chemical constituents. Well USGS 92 contained several purgeable organic compounds.

DOE/ID–22101 Chemical constituents in the dissolved and suspended fractions of ground water from selected sites, Idaho National Engineering Laboratory and vicinity, Idaho, 1989, OFR 92–51, by L.L. Knobel, R.C. Bartholomay, L.D. Cecil, B.J. Tucker, and S.J. Wegner, 1992, 56 p. This report presents a compilation of water-quality data collected during 1989 for 22 wells that tap the Snake River Plain aquifer and for a spring on Big Southern Butte. The samples were collected as part of a study to better understand the geochemical conditions of the ground water. Water samples were analyzed for dissolved cations, anions, silica, trace elements, nutrients, purgeable and semi-volatile organic compounds, dissolved organic carbon, ethylenediaminetetraacidic acid, citrate, tritium, strontium-90, radon-222, gross alpha, beta, and gamma radioactivity, and selected transuranics.

DOE/ID–22102 Radionuclides, inorganic constituents, organic compounds, and bacteria in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1990, OFR 92–91, by R.C. Bartholomay, D.D. Edwards, and L.J. Campbell, 1992, 42 p. This is the second in the series of data reports describing the water quality between the INEL and the Hagerman area. Water samples were collected from 19 of the initial 55 sites and were analyzed for tritium, strontium-

90, radon-222, total uranium, radium, gross alpha, beta, and gamma radioactivity, trace elements, common ions, nutrients, cyanide, dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, herbicides and fecal coliform bacteria.

DOE/ID–22103 Chemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1989–90, OFR 92–156, by L.L. Knobel, R.C. Bartholomay, S.J. Wegner, and D.D. Edwards, 1992, 38 p. This report presents results of Round 1 of a long-term data-collection program to monitor water-quality of the Snake River Plain aquifer in the vicinity of the NRF. The purpose of the data collection program was to provide the NRF with a consistent set of water-chemistry data to evaluate the effects of the NRF activities on the general water quality of the Snake River Plain aquifer. Samples were collected from 13 wells and analyzed for selected anions, total cations, total trace elements, total nutrients, cyanide, surfactants, organic carbon, phosphorous, phenols, turbidity, purgeable and semi-volatile organic compounds, herbicides, insecticides, benzene hexachlorides, polychlorinated compounds, aroclors, tritium, selected radium isotopes, gross alpha and beta radioactivity.

DOE/ID–22104 Purgeable organic compounds in ground water at the Idaho National Engineering Laboratory, Idaho, 1990 and 1991, OFR 92–174, by M.J. Liszewski and L.J. Mann, 1992, 19 p. This is the third in a series of four data reports that presents analytical results for purgeable organic compounds in water samples from the INEL and vicinity. Water samples from 76 wells and 1 hot spring were analyzed for 36 purgeable organic compounds. Water samples from 31 wells contained detectable concentrations of at least 1 of 14 purgeable organic compounds.

DOE/ID–22105 Water-level data for selected wells on or near the Idaho National Engineering Laboratory, Idaho, 1983 through 1990, OFR 92–643, by D.S. Ott, D.D. Edwards, and R.C. Bartholomay, 1992, 307 p. This report presents water-level data for 137 wells in the Snake River Plain aquifer at the INEL for the period 1983 through 1990.

DOE/ID–22106 Chemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1990–91, OFR 93–34, R.C. Bartholomay, L.L. Knobel, and B.J. Tucker, 1993, 70 p. This is the second in the series of reports describing water quality of samples from wells in the vicinity of the NRF at the INEL. Results are presented for water from 12 wells sampled five times at 2-month intervals during 1990–91 and analyzed for dissolved anions, total sodium, total trace elements, nutrients, total organic carbon, phenols, turbidity, gross alpha- and beta-particle radioactivity, radium-226, radium-228, volatile organic compounds, and base/neutral organic compounds. Ten quality-assurance samples also were collected. The USGS National Water Quality Laboratory analyzed all the samples.

DOE/ID–22107 Age dating ground water by use of chlorofluorocarbons (CCl_3F and CCl_2F_2), and distribution of chlorofluorcarbons in the unsaturated zone, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, WRIR 93–4054, E. Busenberg, E.P. Weeks, L.N. Plummer, and R.C. Bartholomay, 1993, 47 p. This report describes the distribution and concentrations of chlorofluorocarbons (CFC's) in ground-water samples at the INEL and vicinity. The results of more than 140 CFC analyses of water from 24 wells and 14 CFC analyses of unsaturated-zone gases from 6 wells at the INEL are presented and interpreted. The recharge ages of the water samples were determined to be from 4 to more than 50 years; the age of most ground-water samples were from 14 to 30 years. The results indicated that young water was added at various locations to the older regional ground water within and outside the INEL boundaries. Soil-gas data indicated that the ground water had equilibrated near or within the thin soil zone and then moved rapidly through the fractured basalts to the water table without gas-water reequilibration.

DOE/ID–22108 Radionuclides, inorganic constituents, organic compounds, and bacteria in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1991, OFR 93–102, by R.C. Bartholomay, D.D. Edwards, and L.J. Campbell, 1993, 42 p. This is the third in the series of data reports describing the water quality between the INEL and Hagerman area. Water samples were collected from 18 sites and analyzed for tritium, strontium-90, gross alpha, beta, and gamma, total uranium, radium, fecal coliform bacteria, trace elements, common ions, nutrients, cyanide, dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22109 Statistical summaries of streamflow data for selected gaging stations on and near the Idaho National Engineering Laboratory, Idaho, through September 1990, WRIR 92–4196, by M.A.J. Stone, L.J. Mann, and L.C. Kjelstrom, 1993, 35 p. This report presents statistical summaries of streamflow data for 13 gaging stations with 5 or more years of record. The streamflow data for the Big and Little Lost Rivers and Birch Creek were analyzed as a requisite for a comprehensive evaluation of the potential for flooding of facilities at the INEL. Different statistics are presented for each gage depending on the length of time of continuous record.

DOE/ID–22110 Concentrations of 23 trace elements in ground water and surface water at and near the Idaho National Engineering Laboratory, Idaho, 1988–91, OFR 93–126, by M.J. Liszewski and L.J. Mann, 1993, 44 p. This report presents analytical data for 23 trace elements in water from 148 wells completed in the Snake River Plain aquifer, 18 wells completed in perched-water zones, 1 well in an alluvial aquifer, 3 streams, 2 springs, 2 ponds, and 1 lake. Water samples were analyzed for either total recoverable or dissolved elements including aluminum, arsenic, barium, beryllium,

cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, zinc, bromide, fluoride, lithium, molybdenum, strontium, thallium, and vanadium. Concentrations of chromium in water from 12 wells equaled or exceeded the maximum contaminant level.

DOE/ID–22111 Concentrations of tritium and strontium-90 in water from selected wells at the Idaho National Engineering Laboratory after purging one, two, and three borehole volumes, WRIR 93–4201, by R.C. Bartholomay, 1993, 21 p. Water from 11 wells completed in the Snake River Plain aquifer at the INEL was sampled as part of the USGS quality-assurance program to determine the effect of purging different volumes of water on the tritium and strontium-90 concentrations. Samples were collected after purging one, two, and three borehole volumes. Results of statistical analyses indicated that concentrations of tritium and strontium-90 are not affected measurably by the number of borehole volumes purged.

DOE/ID–22112 Stable isotopes of hydrogen and oxygen in surface water and ground water at selected sites on or near the Idaho National Engineering Laboratory, Idaho, OFR 94–55, by D.S. Ott, L.D. Cecil, and L.L. Knobel, 1994, 14 p. Relative stable isotopic ratios for hydrogen and oxygen compared to standard mean ocean water are presented for water from 4 surface-water sites and 38 ground-water sites on or near the INEL. Surface-water samples were collected monthly from March 1991 through April 1992, and values ranged from -143.0 to -122 for hydrogen and -18.75 to -15.55 for oxygen. The values for hydrogen and oxygen in water from the ground-water sites ranged from -141.0 to -120.0 and from -18.55 to -14.95, respectively.

DOE/ID–22113 Concentrations of dissolved radon-222 in water from selected wells and springs in Idaho, 1989–91, OFR 94–66, by L.D. Cecil, D.J. Parliman, D.D. Edwards, and H.W. Young, 1994, 40 p. This report presents concentrations of radon-222 in water from 338 wells and springs throughout Idaho collected during 1989–91. Concentrations in 372 samples ranged from -58±30 to 5,715±66 pCi/L; the mean and median concentrations were 446±35 and 242±25 pCi/L, respectively.

DOE/ID–22114 Radionuclides, inorganic constituents, organic compounds, and bacteria in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1992, OFR 94–76, by R.C. Bartholomay, D.D. Edwards, and L.J. Campbell, 1994, 41 p. This is the fourth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEL and the Hagerman area. Water samples were collected from 18 sites and were analyzed for tritium, strontium-90, gross alpha, beta, and gamma, total uranium, radium, fecal coliform bacteria, trace elements, common ions, nutrients, cyanide, dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22115 Iodine-129 in the Snake River Plain aquifer at and near the Idaho National Engineering Laboratory, Idaho, 1990–91, WRIR 94–4053, by L.J. Mann and T.M. Beasley, 1994, 27 p. This report describes the iodine-129 (I-129) sampling and anaysis program of 1990–91 and changes in the concentration and distribution of I-129 in the aquifer from 1986 to 1991. Because of its 15.7-million year radioactive half-life, I-129 is a permanent environmental pollutant. Between 1953 and 1990, an estimated 0.56 to 1.18 curies of I-129 was disposed at the ICPP (now INETEC). During 1990–91, water samples were collected from 51 wells completed in the Snake River Plain aquifer and 1 well completed in a perched-water zone. Samples were analyzed using the accelerator mass spectrometer method, which is much more sensitive than previous methods used. Ground-water flow velocities calculated using I-129 data were at least 6 ft per day, which was comparable to velocities determined in other studies. The concentrations of iodine-129 ranged from 0.0000006±0.0000002 to 3.82±0.19 pCi/L. Concentrations in the aquifer decreased between 1986 and 1990–91, chiefly as a result of a decrease in the amount of I-129 disposed of annually and changes in waste-disposal techniques.

DOE/ID–22116 Mineralogy of selected sedimentary interbeds at or near the Idaho National Engineering Laboratory, Idaho, OFR 94–374, by M.F. Reed and R.C. Bartholomay, 19 p. This report presents bulk and clay mineralogy from 66 samples from sedimentary-interbed samples from 22 sites at the INEL. Data indicated that percentages of quartz, total feldspar, and total clay minerals were larger and percentages of calcite were smaller in samples from the Big Lost River basin than percentages of the same minerals in samples from the Birch Creek basin.

DOE/ID–22117 Radionuclides, stable isotopes, inorganic constituents, and organic compounds in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1993, OFR 94–503, by R.C. Bartholomay, D.D. Edwards, and L.J. Campbell, 1994, 35 p. This is the fifth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEL and the Hagerman area. Water samples from 19 sites were analyzed for tritium, strontium-90, gross alpha and beta radioactivity, stable isotopes of hydrogen, oxygen, carbon, sulfur, and nitrogen, trace elements, common ions, nutrients, dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22118 Hydrological and meteorological data for an unsaturated-zone study area near the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho, 1988 and 1989, OFR 95–112, by J.R. Pittman, 1995, 120 p. This is the third in a series of five data reports that provide information for estimating the potential for migration of radionuclides in the unsaturated zone at the RWMC. A simulated-waste trench was completed in the

spring of 1988 and instrumented to add additional data to the study. The report presents daily measurements of soil temperature and soil-water potential, volumetric moisture content of soils, variations of volumetric soil-water content at various data-collection sites, and meteorological data used to determine evapotranspiration rates. These data were collected to determine reliable estimates of the amount of water that infiltrates the surficial sediment and eventually recharges the aquifer and to aid in the calibration of a numerical model to determine the potential for migration of radionuclides in the unsaturated zone.

DOE/ID–22119 Tritium, stable isotopes and nitrogen in flow from selected springs that discharge to the Snake River, Twin Falls-Hagerman area, Idaho, 1990–93, WRIR 94–4247, by L.J. Mann and W.H. Low, 1994, 21 p. This report presents tritium data from the long-term program initiated in 1989 to monitor tritium in 19 springs that discharge to the Snake River. Tritium concentrations in the springs ranged from 9.2±0.6 to 78.4±5.1 pCi/L. Three categories of springs were established on the basis of location and tritium concentration. The differences in the categories were related to ground-water flow regimes and land uses upgradient from the springs. Nitrate data and isotopes of hydrogen and oxygen were used to support the theories on source water for the different springs.

DOE/ID–22120 Analysis of steady-state flow and advective transport in the eastern Snake River Plain aquifer system, Idaho, WRIR 94–4257, by D.J. Ackerman, 1995, 25 p. This report describes compartments in the aquifer that function as intermediate and regional flow systems, describes pathlines for flow originating at or near the water table, and quantifies traveltimes for advective transport originating at or near the water table. The study was limited by the scope, assumptions, and resolution of the Garabedian model report (Garabedian, 1992) and describes the same time period, 1950–80, which represented relatively stable flow conditions. Traveltimes for advective flow from the water table to discharge points in the regional compartment ranged from 12 to 350 years for 80 percent of the particles; in the intermediate compartment near American Falls Reservoir, from 7 to 60 years for 80 percent of the particles; and in the intermediate-scale compartment near Mud Lake, from 25 to 100 years for 80 percent of the particles. The model was calibrated on the basis iodine-129 concentrations in the system and a porosity of 0.21.

DOE/ID–22121 Changes in soil hydraulic properties caused by construction of a simulated waste trench at the Idaho National Engineering Laboratory, Idaho, WRIR 95–4058, by S. Shakofsky, 1995, 26 p. This report compares the hydraulic characteristics of both the undisturbed soil and the disturbed soil of the simulated waste trench, focusing on the changes that occur when soil is disturbed. The texture, bulk density, porosity, and aggregation of an undisturbed and disturbed soil and the effects of these properties on soil-moisture retention and hydraulic conductivities were examined. Results showed that substantial differences exist between the physical and hydraulic properties of the undisturbed and disturbed soils.

DOE/ID–22122 Stratigraphy of the unsaturated zone and uppermost part of the Snake River Plain aquifer at Test Area North, Idaho National Engineering Laboratory, Idaho, WRIR 95–4130, by S.R. Anderson and B. Bowers, 1995, 47 p. This report describes the stratigraphic framework of the unsaturated zone and uppermost part of the Snake River Plain aquifer at the TAN using geophysical and geologic data collected through March 1993. Wells drilled to at least 500 ft penetrate 10 basalt-flow groups and 5 to 10 sedimentary interbeds. The basalt flows in this area are much older than those in the southern part of the INEL. Altitude and thickness of the different units are given in table 1.

DOE/ID–22123 Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1989 through 1991, WRIR 95–4175, by R.C. Bartholomay, B.R. Orr, M.J. Liszewski, and R.G. Jensen, 1995, 47 p. This is the seventh in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer. The report also presents an analysis of water-level and water-quality data collected for the Snake River Plain aquifer during 1989–91. Water levels generally declined (up to 10 ft north of the NRF) during 1989–91 as a result of drought. Tritium concentrations decreased as much as 23.8 pCi/mL, and the maximum concentration in October 1991 was 41.7±0.9 pCi/mL. In 1989, concentrations of cobalt-60, cesium-137, and plutonium isotopes in water samples from the TAN Disposal (now TAN/TSF Injection) well were larger than the reporting level. Sodium and chloride concentrations south of the ICPP (now INTEC) increased as a result of increased disposal. Well USGS 65 contained 200 µg/L of chromium. Plumes of 1,1,1-trichloroethane had developed south of the ICPP and near the RWMC as a result waste-disposal practices.

DOE/ID–22124 Radionuclides, stable isotopes, inorganic constituents, and organic compounds in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1994, OFR 95–718, by R.C. Bartholomay, L.M. Williams, and L.J. Campbell, 1995, 37 p. This is the sixth in the series of data reports describing the water quality between the INEL and the Hagerman area. Water samples were collected from 18 sites and analyzed for tritium, strontium-90, gross alpha, beta, and gamma radioactivity, stable isotopes of oxygen, hydrogen, sulfur, carbon, and nitrogen, trace elements, common ions, nutrients, dissolved organic carbon, surfactants, purgeable organic compounds, insecticides, herbicides, and gross polychlorinated compounds.

DOE/ID–22125 Chemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1991–93, OFR 95–725, by B.J. Tucker, L.L. Knobel, and R.C. Bartholomay, 1995, 94 p. This is the third in the series of reports describing water quality of samples from wells in the vicinity of the NRF at the INEL. The report presents Round-1, -2, and -3 water chemistry data. First-time analyses of samples from wells

NRF 6 and NRF 7 are presented. The purpose of this study was to provide the NRF Idaho Branch Office with water-chemistry data to evaluate the effects of NRF activities on the water quality of the Snake River Plain aquifer. Most of the data presented are Round-3 samples from 14 wells collected quarterly and analyzed for chloride, sulfate, sodium, bromide, fluoride, selected trace elements, dissolved nutrients, total organic carbon, and gross alpha and beta radioactivity.

DOE/ID–22126 Chemical composition of selected core samples, Idaho National Engineering Laboratory, Idaho, OFR 95–748, by L.L. Knobel, L.D. Cecil, and T.R. Wood, 1995, 59 p. This report presents chemical compositions of 84 subsamples and 5 quality-assurance split subsamples of basalt cores from 5 coreholes at the INEL. Ten major elements and as many as 32 trace elements were determined for each sample either by dispersive X-ray fluorescence spectrometry, inductively coupled plasma mass spectrometry, or both methods. Descriptive statistics for each element also were presented.

DOE/ID–22127 Stratigraphic data for wells at and near the Idaho National Engineering Laboratory, Idaho, OFR 96–248, by S.R. Anderson, D.J. Ackerman, M.J. Liszewski, and R.M. Freiburger, 1996, 27 p. and 1 diskette. This report describes a database containing information on 230 stratigraphic units in 333 wells that make up the unsaturated zone and the Snake River Plain aquifer at and near the INEL. The stratigraphic units, which were identified and correlated using the data from numerous outcrops, 26 continuous cores, and 328 natural-gamma logs available in December 1993, include 121 basalt-flow groups, 102 sedimentary interbeds, 6 andesite-flow groups, and 1 rhyolite dome. The stratigraphic data are presented on a diskette included with the report.

DOE/ID–22128 Thickness of surficial sediment at and near the Idaho National Engineering Laboratory, Idaho, OFR 96–330, by S.R, Anderson, M.J. Liszewski, and D.J. Ackerman, 1996, 16 p. This report describes the thickness of surficial sediment, determined from natural-gamma logs of 333 wells at and near the INEL, to provide reconnaissance data for future site-characterization studies. Thickness of surficial sediment ranged from 0 ft in 7 wells east of the ICPP (now INTEC) to 313 ft in well Site 14 southeast of the Big Lost River Sinks.

DOE/ID–22129 Evaluation of quality-assurance/quality-control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1989 through 1993, WRIR 96–4148, by L.M. Williams, 1996, 116 p. This report presents an evaluation of the quality assurance/quality control data from the USGS INEL Project Office water-quality monitoring program from 1989 to 1993. Statistical comparisons were done to evaluate the precision of field and laboratory methods for hundreds of water samples collected from 177 monitoring sites. The statistical comparison showed that 96 percent of the replicate pairs were equivalent. Ninety percent or more of the results for each pair were equivalent, except those for ammonia plus organic nitrogen, orthophosphate, iron, manganese, radium-226, total organic carbon, and total phenols.

DOE/ID–22130 Radionuclides, stable isotopes, inorganic constituents, and organic compounds in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1995, OFR 96–496, by R.C. Bartholomay, L.M. Williams, and L. J. Campbell, 1996, 29 p. This is the seventh in the series of data reports describing the water quality between the INEL and the Hagerman area. Water samples were collected from 17 sites and analyzed for tritium, strontium-90, gross alpha and beta, stable isotopes, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22131 Evaluation of preservation methods for selected nutrients in ground water at the Idaho National Engineering Laboratory, Idaho, WRIR 96–4260, by R.C. Bartholomay and L.M. Williams, 1996, 16 p. Water samples from 28 wells at the INEL were collected and analyzed as part of the quality-assurance program to determine the effect of different preservation methods on nutrient concentrations. Water samples were preserved with filtration and with mercuric chloride and chilling, chilling only, and sulfuric acid and chilling and were analyzed for ammonia, nitrite, nitrite plus nitrate, and orthophosphate. Statistical comparisons of analytical results for the samples showed that all results were in statistical agreement, which indicated that changing the preservation methods did not affect comparability of data collected before and after October 1994 when the standard method was changed from filtration, preservation with mercuric chloride, and chilling, to filtration and chilling.

DOE/ID–22132 Quality-assurance plan and field methods for quality-of-water activities, U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho, OFR 96–615, L.J. Mann, 1996, 37 p. The report outlines responsibilities of the INEL Project Office staff in maintaining and improving the quality of technical products and in providing a formal standardization, documentation, and review of activities that lead to these products. Data-quality objectives, methods for sampling and preservation, review of analyses, performance audits, corrective actions, information on water-quality sampling schedules, and water-quality field equipment are listed.

DOE/ID–22133 Evaluation of radionuclide, inorganic constituent, and organic compound data from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1989 through 1992, WRIR 97–4007, by R.C. Bartholomay, L.M. Williams, and L. J. Campbell, 1997, 73 p. This report evaluates the USGS data collected from 55 sites during the first and second rounds of sampling and analyses to describe water quality between the INEL and the Hagerman area. Results from the first two rounds were compared statistically to determine whether water quality changed between rounds and also to determine precision of analyses for individual constituents, which could help to determine sampling strategy in future rounds. Comparisons of radionuclide data showed no pattern of water-quality changes; concentrations randomly

increased or decreased. Comparisons of most inorganic- and organic-constituent data showed no statistical changes in water quality between samples.

DOE/ID–22134 Geologic ages and accumulation rates of basalt-flow groups and sedimentary interbeds in selected wells at the Idaho National Engineering Laboratory, Idaho, WRIR 97–4010, by S.R. Anderson, M.J. Liszewski, and L.D. Cecil, 1997, 39 p. This report describes a range of estimated geologic ages and accumulation rates that were used to evaluate reported measured geologic ages and interpreted stratigraphic and structural relations of basalt and sediment in the unsaturated zone and the Snake River Plain aquifer at the INEL. Ages and maximum accumulation rates were estimated from standard linear regressions of 21 mean potassium-argon ages, selected mean paleomagnetic ages, and cumulative depths of a composite stratigraphic section composed of complete intervals of basalt and sediment that were deposited in areas of past maximum subsidence. Estimated ages ranged from about 200 thousand to 1.8 million years before present and were reasonable for the interval of basalt and sediment above the effective base of the aquifer. Accumulation rates, estimated from regressions of stratigraphic intervals younger than 640 thousand years in three wells in and adjacent to an area of interpreted uplift near the ICPP (now INTEC) and the TRA, ranged from 59 to 282 ft/100,000 years and averaged 163 ft/100,000 years.

DOE/ID–22135 Procedures for use of, and drill cores and cuttings available for study at, the lithologic core storage library, Idaho National Engineering Laboratory, Idaho, OFR 97–124, by L.C. Davis, S.R. Hannula, and B. Bowers, 1997, 31 p. This report describes the Lithologic Core Storage Facility and cores and cuttings stored at the facility. The Lithologic Core Storage Facility was established to consolidate, catalog, and permanently store nonradioactive drill cores and cuttings from investigations of the subsurface at the INEL and to provide a location for researchers to examine, sample, and test these materials. The report describes the procedures and researchers' responsibilities for access to the facility, and for examination, sampling, and return of materials.

DOE/ID–22136 Evaluation of quality assurance/quality control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1994 through 1995, WRIR 97–4058, by L.M. Williams, 1997, 87 p. This report presents an evaluation of the quality-assurance/quality-control data from the USGS INEL Project office water-quality monitoring program. Approximately 4,000 water samples were collected for analyses during 1994–95, and more than 500 of the samples were quality-assurance blanks or replicates. Statistical comparisons were done to evaluate the precision of field and laboratory methods. These comparisons showed that 95 percent of the replicate pairs were equivalent. Ninety percent or more of the pairs for each constituent were equivalent, except those for nitrite, orthophosphate, phosphorus, aluminum, iron, strontium-90, and total organic carbon.

DOE/ID–22137 Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1992 through 1995, WRIR 97–4086, by R.C. Bartholomay, B.J. Tucker, D.J. Ackerman, and M.J. Liszewski, 1997, 57 p. This is the eighth in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer. The report presents an analysis of water-level and water-quality data collected for the Snake River Plain aquifer at the INEL during 1992 through 1995. Water levels at the INEL declined (more than 8 ft north of the NRF) during this period because of drought. Tritium concentrations in the aquifer continued to decrease, as much as 16.6 pCi/mL in one well, owing to decreases in disposal, radioactive decay, and changes in waste-disposal methods. Tritium concentrations were greater than the MCL for drinking water in water from only five wells. Concentrations of americium-241 were at the reporting level in water from two wells. Sections on reported concentrations for gross alpha- and beta-particle radioactivity, trace elements, fluoride, and total organic carbon are presented for the first time in update reports because of the initiation in 1993 of sampling for the INEL ground-water-monitoring program. Most of the changes in ion concentrations represented increases or decreases in waste-disposal rates.

DOE/ID–22138 Simulation of water-surface elevations for a hypothetical 100-year peak flow in Birch Creek at the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 97–4083, by C.E. Berenbrock and L.C. Kjelstrom, 1997, 20 p. This report delineates the areal extent of possible flooding at the INEEL resulting from peak flow in Birch Creek having a recurrence interval of 100 years. Twenty-six cross sections were surveyed within the boundary of the INEEL to provide data for the development of a floodplain model. The model simulated a hypothetical 100-year peak flow in the Birch Creek and calculated water-surface elevations along the surveyed cross sections. The water-surface elevations were used to delineate the extent of flooding caused by the hypothetical peak flow. Results showed that dikes around the northern facilities would prevent water from the hypothetical 100-year peak flow from flooding any of the facilities.

DOE/ID–22139 Preliminary delineation of natural geochemical reactions, Snake River Plain aquifer system, Idaho National Engineering Laboratory and vicinity, Idaho, WRIR 97–4093, by L.L Knobel, R.C. Bartholomay, and B.R. Orr, 1997, 52 p. This report presents a preliminary delineation of natural geochemical reactions occurring in the Snake River Plain aquifer as part of the continuing hydrogeologic investigations at the INEL. The report describes the mineralogy, mineral stability, ion distribution, hydrochemical facies, and thermodynamic condition of the aquifer system. Reactants and products that contribute significantly to the natural geochemistry include labradorite, olivine, pyroxene, smectite, calcite, ferric oxyhydroxide, and several silica phases. Principal reactions modifying the natural system

include congruent dissolution of olivine, diopside, amorphous silica, and anhydrite; incongruent dissolution of labradorite, with calcium montmorillonite as a residual product; precipitation of calcite and ferric oxyhydroxide; and oxidation of ferrous iron to ferric iron. Effects of waste disposal at the INEL on the geochemical environment also are given.

DOE/ID–22140 Strontium distribution coefficients of surficial sediment samples from the Idaho National Engineering Laboratory, Idaho, WRIR 97–4044, by M.J. Liszewski, J.J. Rosentreter, and K.E. Miller, 1997, 33 p. Strontium distribution coefficients for 20 surficial-sediment samples collected from selected sites at the INEL were measured to help assess the variability of strontium distribution coefficients found at the INEL. Batch experiments were done using a synthesized aqueous solution representative of wastewater in disposal ponds at the INEL. Strontium distribution coefficients ranged from 36±1 to 275±6 mL/g. Results indicated significant variability in strontium sorptive capacities of the surficial sediments at the INEL.

DOE/ID–22141 Radiochemical and chemical constituents in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1996, OFR 97–360, by R.C. Bartholomay, L.M. Williams, and L. J. Campbell, 1997, 29 p. This is the eighth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEL and the Hagerman area. Water samples were collected from one site to finish the Round-3 sampling and from 19 sites as part of the Round-4 sampling. Samples were analyzed for tritium, strontium-90, gross alpha and beta, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22142 Stratigraphy of the unsaturated zone and the Snake River Plain aquifer at and near the Idaho National Engineering Laboratory, Idaho, WRIR 97–4183, by S.R. Anderson and M.J. Liszewski, 1997, 65 p. This report summarizes the results of the stratigraphic study and describes the stratigraphic relations for the INEL and adjacent areas. The report describes the distribution of 292 stratigraphic units and 14 composite stratigraphic units that make up the unsaturated zone and the Snake River Plain aquifer at and near the INEL. Stratigraphic units include 178 basalt-flow groups, 103 sedimentary interbeds, 6 andesite-flow groups, and 4 rhyolite domes. The units were identified and correlated using the data from numerous outcrops, 26 continuous cores, and 328 natural-gamma logs. Composite units 1 through 7 generally range in age from about 200 to 800 thousand years and make up the unsaturated zone and the uppermost part of the aquifer in most places. Units 8 through 14 range in age from about 800 thousand to 1.8 million years and make up the unsaturated zone and aquifer in the northern part of the INEL and the lowermost part of the aquifer elsewhere. Several stratigraphic cross sections of the INEL and the altitudes of various units are presented.

DOE/ID–22143 Chemical and radiochemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1994–95, OFR 97–806, by R.C. Bartholomay, L.L Knobel, and B.J. Tucker, 1997, 70 p. This is the fourth in the series of reports describing water quality of samples from wells in the vicinity of the NRF at the INEL. Results are presented for samples collected quarterly from 14 wells during 1994–95. Samples were analyzed for dissolved anions, sodium, total trace elements, nutrients, total organic carbon, gross alpha- and beta-particle radioactivity and tritium. Twelve quality-assurance samples also were collected.

DOE/ID–22144 Distribution of selected radiochemical and chemical constituents in perched ground water, Idaho National Engineering Laboratory, Idaho, 1989–91, WRIR 98–4028, by B.J. Tucker and B.R. Orr, 1998, 62 p. This is the second in a series of reports covering the effects of waste disposal on the distribution of constituents in perched-water zones at the INEL. The report covers the period 1989–91 and presents the results for tritium, strontium-90, gross gamma, chromium, sodium, chloride sulfate, fluoride, and nutrients from perched-water wells at the TRA and the ICPP (now INTEC) and results for purgeable organic compounds, plutonium, and americium from well USGS 92 at the RWMC. The largest tritium concentration in 1991 in deep perched ground water at the TRA was 785±12 pCi/mL. Variability in tritium concentrations was related to variable disposal rates, distance of wells from the warm-waste ponds, and depth to water. Tritium concentrations from wells near the ICPP decreased because of decreased disposal rates. Samples were not routinely analyzed for sulfate before 1989. The analysis for sulfate was added to the sampling program in 1989 at selected wells and the first results were published in this report.

DOE/ID–22145 Distribution of selected radiochemical and chemical constituents in perched ground water, Idaho National Engineering Laboratory, Idaho, 1992–95, WRIR 98–4026, by R.C. Bartholomay, 1998, 59 p. This is the third in the series of reports covering the effects of waste disposal on the distribution of constituents in perched-water zones at the INEL. The report covers the period 1992–95 and presents the results for tritium, strontium-90, gross gamma, chromium, sodium, chloride, sulfate, and nitrate from perched-water wells at the TRA and the ICPP (now INTEC) and results for purgeable organic compounds, plutonium, and americium from well USGS 92 at the RWMC. Concentrations of plutonium-238 and americium-241 were 0.39±0.05 and 0.14±0.04 pCi/mL, respectively, in one sample each. The largest tritium concentration in 1995 in deep perched water at the TRA was 158±5 pCi/mL. Variability in tritium concentrations was related to variable disposal rates, distance of wells from the warm-waste ponds, depth to water, discontinued use of the warm-waste ponds at the TRA in 1993, radioactive decay, and dilution from nonradioactive water. Tritium concentrations in water from wells near the ICPP decreased because of decreased disposal rates. Routine analyses for sulfate began in 1995 and results are presented.

DOE/ID–22146 Purgeable organic compounds in water at or near the Idaho National Engineering Laboratory, Idaho, 1992–95, OFR 98–51, by M.R. Greene and B.J. Tucker, 1998, 21 p. This is the last in a series of four data reports that presents analytical results for purgeable organic compounds in water samples from the INEL and vicinity. Water samples from 54 wells and 6 surface-water sites were analyzed for 63 purgeable organic compounds. Water samples from 23 wells contained detectable concentrations of at least 1 of 14 purgeable organic compounds.

DOE/ID–22147 Evaluation of archived water samples using chlorine isotopic data, Idaho National Engineering and Environmental Laboratory, Idaho, 1966–93, WRIR 98–4008, L.D. Cecil, S. Frape, R. Drimmie, H. Flatt, and B.J. Tucker, 1998, 27 p. This report describes the comparison of data from analyses of water samples from the USGS archive library. Water samples collected at different historical times during the period 1966–93 from six USGS monitoring wells and from one 1970-sample from a surface-water site were analyzed for stable chlorine-37/chlorine-35 (Cl-37/Cl-35) ratios. The Cl-37/Cl-35 ratios were compared to see if fractionation of chlorine isotopes has occurred during storage. Results of this study indicated that the chlorine-36 concentrations, which were measured in 1993 for each historical sample, were representative of the concentrations in the samples at the time of sample collection (1966–93).

DOE/ID–22148 Preliminary water-surface elevations and boundary of the 100-year peak flow in the Big Lost River at the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 98–4065, C. Berenbrock and L.C. Kjelstrom, 1998, 13 p. This report presents results of a study to calculate water-surface elevations and delineate the areal extent of possible flooding at the INEEL that would result from peak flow in the Big Lost River having a recurrence interval of 100 years. Thirty-seven channel cross sections were surveyed to develop and apply a one-dimensional hydraulic model to calculate water-surface elevations and estimate the areas of inundation for the 100-year peak flow in the Big Lost River. Results using a 7,260 ft^3/sec peak flow indicated that the northern part of the ICPP (now INTEC) would be flooded. The experimental dairy farm northeast of the ICPP also would be flooded. Application of more stringent models is needed to refine and better delineate the extent of possible flooding of the Big Lost River at the INEEL.

DOE/ID–22149 Strontium distribution coefficients of surficial and sedimentary interbed samples from the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 98–4073, by M.J. Liszewski, J.J. Rosentreter, K.E. Miller, and R.C. Bartholomay, 1998, 55 p. Strontium distribution coefficients (Kd's) for 21 surficial and 17 sedimentary-interbed samples, collected from selected sites at the INEEL were measured to help assess the variability of strontium Kd's found at the INEEL. Batch experiments were done using a synthesized aqueous solution representative of wastewater in disposal ponds at the INEEL. Strontium Kd's ranged from 26±1 to 328±41 mL/g. Results indicated significant variability in strontium sorptive capacities of the surficial and interbedded sediments at the INEEL.

DOE/ID–22150 Evaluation of quality-assurance/quality-control data collected by the U.S. Geological Survey from wells and springs between the southern boundary of the Idaho National Engineering and Environmental Laboratory and the Hagerman area, Idaho, 1989 through 1995, WRIR 98–4206, by L.M. Williams, R.C. Bartholomay, and Linford J. Campbell, 1998, 83 p. This report presents an evaluation of the quality-assurance/quality-control data from the USGS INEEL Project Office water-quality monitoring program between the southern boundary of the INEEL and the Hagerman area. Statistical comparisons were done to evaluate the precision of field and laboratory methods for 15 replicate samples, 3 blank samples, and 5 equipment-blank samples. The statistical comparisons showed that 95 percent of the replicate water-sample pairs were equivalent. Ninety percent or more of the results for each were equivalent except those for orthophosphate, aluminum, vanadium, zinc, gross alpha, gross beta, radon-222, radium-226, strontium-90, tritium, gamma radiation, methylene blue active substances (MBAS), and stable isotopic ratios of carbon-13/carbon-12 and nitrogen-15/nitrogen-14.

DOE/ID–22151 Chlorofluorocarbons, sulfur hexafluoride, and dissolved permanent gases in ground water from selected sites in and near the Idaho National Engineering and Environmental Laboratory, Idaho, 1994–97, OFR 98–274, E. Busenberg, L.N. Plummer, R.C. Bartholomay, and Julian Wayland, 1998, 72 p. This report presents results for water samples from 86 wells at and around the INEEL that were analyzed for dichlorodifluoromethane, trichlorofluoromethane, trichlorotrifluoroethane, sulfur hexafluoride, and dissolved gases of nitrogen, argon, carbon dioxide, oxygen, and methane. The data were collected to help determine the age of ground water at the INEEL; the ages can be used to determine recharge rates, residence times, and traveltimes of water in the Snake River Plain aquifer.

DOE/ID–22152 Radiochemical and chemical constituents in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1997, OFR 98–646, by R.C. Bartholomay, L.M. Williams, and L. J. Campbell, 1998, 30 p. This is the ninth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEEL and the Hagerman area. Water samples were collected from 18 sites as part of Round-4 sampling. Samples were analyzed for tritium, strontium-90, gross alpha and beta, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22153 Strontium distribution coefficients of basalt core samples from the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 98–4256, by J.J. Colello, J.J. Rosentreter, R.C. Bartholomay, and M.J. Liszewski, 1998, 68 p. Strontium distribution coefficients

(Kd's) were measured for 24 basalt core samples collected from selected sites at the INEEL to help assess the variability of strontium Kd's found at the INEEL. Batch experiments were done using a synthesized aqueous solution representative of wastewater in disposal ponds at the INEEL. Strontium Kd's ranged from 3.6±1.3 to 29.4±1.6 mL/g. Results indicated a narrow range of variability in the strontium sorptive capacities of basalt relative to those of the sedimentary materials at the INEEL. The small Kd's indicated that basalt is not a major contributor in preventing the movement of strontium-90.

DOE/ID–22154 Hydrologic and meteorological data for an unsaturated-zone study area near the Radioactive Waste Management Complex, Idaho National Engineering and Environmental Laboratory, Idaho, 1990–96, OFR 98–9, by K.S. Perkins, J.R. Nimmo, and J.R. Pittman, 1998, 13 p., 1 diskette. This is the fourth in a series of five data reports that provide information for estimating the potential for migration of radionuclides in the unsaturated zone at the RWMC. Three additional neutron access holes were completed in 1994 to expand data collection for an infiltration and redistribution test in the simulated waste trench. The report presents monthly soil-moisture-content measurements for the period 1990–96 and meteorological data for the test-trench area during 1994–96. The meteorological station, inside the test trench area, provided data for determination of evapotranspiration rates. The station measured soil-surface temperature, net radiation, air temperature, relative humidity, vapor pressure, windspeed, wind direction, soil-heat flux, and precipitation. These data were collected to determine reliable estimates of the amount of water that infiltrates the surficial sediment and eventually recharges the aquifer and to aid in the calibration of a numerical model to determine the potential for migration of radionuclides in the unsaturated zone.

DOE/ID–22155 Geologic controls of hydraulic conductivity in the Snake River Plain aquifer at and near the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 99–4033, by S.R. Anderson, M.A. Kuntz, and L.C. Davis, 1999, 38 p. This report describes numerous geologic controls of hydraulic conductivity in the Snake River Plain aquifer at and near the INEEL. Specifically, the report proposes and describes a relation, not previously documented at the INEEL, between hydraulic conductivity, basalt stratigraphy, and the distribution of vents, dikes, and fissures in volcanic rift zones at and near the INEEL. Forty-five vent corridors are inferred to be beneath the INEEL and adjacent areas. In many of the corridors, water from the upper 200 ft of the aquifer is 1 to 7 °C warmer than the median temperature of water throughout the aquifer. The effective hydraulic conductivity of basalt and interbedded sediment that compose the Snake River Plain aquifer at the INEEL ranges from about $1.0x10^{-2}$ to $3.2x10^{4}$ ft/day. This variability of conductivity was attributed mainly to the physical characteristics and distribution of basalt flows and dikes. Hydraulic conductivity is greatest in thin pahoehoe flows and near-vent volcanic deposits and is least in flows and deposits cut by dikes. Three broad categories of hydraulic conductivity corresponding to six general types of geologic controls are inferred and presented from the distribution of wells and vent corridors.

DOE/ID–22156 Chlorine-36 in water, snow, and mid-latitude glacial ice of North America: meteoric and weapons-tests production in the vicinity of the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 99–4037, by L.D. Cecil, J.R. Green, S. Vogt, S.K. Frape, S.N. Davis, G.L. Cottrell, and P. Sharma, 1999, 27 p. Concentrations of chlorine-36 in 64 water, snow, and glacial-ice and -runoff samples were measured to determine the meteoric and weapons-tests-produced concentrations and fluxes of this radionuclide at mid-latitudes in North America. Measurement results indicated a meteoric source for chlorine-36 concentrations less than $1x10^{7}$ atoms/L in environmental samples. Chlorine-36 concentrations larger than $1x10^{9}$ atoms/L were attributed to waste-disposal practices.

DOE/ID–22157 The use of chemical and physical properties for characterization of strontium distribution coefficients at the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 99–4123, by J.J. Rosentreter, R. Nieves, J. Kalivas, J.P. Rousseau, and R.C. Bartholomay, 1999, 25 p. This report summarizes the results of using multivariate-regression techniques to identify which variables or set of variables can best predict strontium distribution coefficient (Kd) values. The variables used were derived from an earlier study done to experimentally determine strontium Kd's of 20 surficial-sediment samples at the INEEL. Partial least-squares regression techniques were used to fit the data to an empirical model that could be used to predict strontium Kd's of surficial sediments. The best-fit model was obtained using a four-variable data set consisting of surface area, manganese oxide concentration, specific conductance, and pH. Prediction-variable selection was limited to variables that are either easily determined or have available tabulated characteristics.

DOE/ID–22158 Strontium distribution coefficients of basalt and sediment infill samples from the Idaho National Engineering and Environmental Laboratory, Idaho, WRIR 99–4145, by M.N. Pace, J.J. Rosentreter, and R.C. Bartholomay, 1999, 56 p. This report presents experimentally derived strontium distribution coefficients (Kd's) of six basalt-core samples and five sediment-infill samples from a core near the INTEC (formerly the ICPP). The samples were collected for comparison of Kd's with basalt, surficial-sediment and sedimentary-interbed samples that previously had been studied. Results showed that Kd's for infill samples ranged from 201.6±10.8 to 356.2±8.4 mL/g. Kd's for basalt samples ranged from 1.3±8.4 to 9.3±9.8 mL/g. Mineralogy, Brunauer-Emmett-Teller surface area, and whole rock analysis data for the 11 samples is presented in tables 1-3.

DOE/ID–22159 Chemical constituents in ground water from 39 selected sites with an evaluation of associated quality assurance data, Idaho National Engineering and Environmental Laboratory and vicinity, Idaho, OFR 99–246, by L.L. Knobel,

R.C. Bartholomay, B.J. Tucker, L.M. Williams, and L.D. Cecil, 1999, 58 p. This report presents a compilation of water-quality data and an evaluation of associated quality-assurance data collected during 1990–94 from 37 wells completed in the Snake River Plain aquifer and two springs from areas that provide recharge to the aquifer. The data were collected as part of the continuing hydrogeologic investigation at the INEEL. Samples were analyzed for dissolved cations and anions, purgeable organic compounds, extractable acid and base/neutral organic compounds, dissolved organic carbon, selected radionuclides, and stable isotopes of hydrogen, oxygen, carbon, sulfur, and nitrogen.

DOE/ID–22160 Chemical and radiochemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1996, OFR 99–272, by L.L. Knobel, R.C. Bartholomay, B.J. Tucker, and L.M. Williams, 1999, 58 p. This is the fifth in the series of reports describing water quality of samples from wells in the vicinity of the NRF at the INEEL. Results are presented for samples collected quarterly from 13 wells during 1996. Samples were analyzed for dissolved chloride and sulfate, total cations, total trace elements, nutrients, total organic carbon, gross alpha- and beta-particle radioactivity, strontium-90, tritium, and gamma-emitting radioisotopes, volatile organic compounds, and base/neutral organic compounds. Seven quality-assurance water samples also were collected. First-time analyses of samples from wells NRF 8–13 are presented.

DOE/ID–22161 Radiochemical and chemical constituents in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1998, OFR 99–473, by R.C. Bartholomay, B.V. Twining, and L. J. Campbell, 1999, 28 p. This is the tenth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEL and the Hagerman area. Water samples were collected from 18 sites during June and August of 1998 to complete Round 4 of the study. Water samples were analyzed for tritium, strontium-90, gross alpha and beta, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22162 A transient numerical simulation of perched ground-water flow at the Test Reactor Area, Idaho National Engineering and Environmental Laboratory, Idaho, 1952–94, WRIR 99–4277, by B.R. Orr, 1999, 54 p. This report describes the development of a transient numerical simulation that was used to evaluate a conceptual model of flow through perched ground-water zones beneath wastewater infiltration ponds at the TRA. Perched water beneath the TRA has been detected in two basalt-flow groups and three sedimentary-interbed units. A four-layer numerical model representative of different lithologies at different depths was used to evaluate perched ground-water flow in the upper 200 ft of the unsaturated zone. A simulation that assumed cessation of all wastewater recharge showed that the perched ground-water zones would drain about four years after cessation of recharge. Measured water levels in some wells indicated that Big Lost River recharge also contributes water to some perched zones.

DOE/ID–22163 Laboratory and field hydrologic characterization of the shallow subsurface at an Idaho National Engineering and Environmental Laboratory waste-disposal site, WRIR 99–4263, by J.R. Nimmo, S.M. Shakofsky, J.F. Kaminsky, and G.S. Lords, 1999, 31 p. This report presents the results of a study to assess whether hydraulic properties measured carefully by standard laboratory and field techniques can predict the character of flow in the unsaturated zone at the RWMC, and how much the mechanical disturbance of the unsaturated-zone materials influences these properties.

DOE/ID–22164 Chemical and isotopic composition and gas concentrations of ground water and surface water from selected sites at and near the Idaho National Engineering and Environmental Laboratory, Idaho, 1994–97, OFR 00–81, by E. Busenberg, L.N. Plummer, M.W. Doughten, P.K. Widman, and R.C. Bartholomay, 2000, 51 p. This report presents analytical results of water samples from 86 wells, 5 surface-water sites, and 3 springs at and around the INEEL. Samples were analyzed for all major elements, 22 trace elements, scandium, yttrium, and 14 rare-earth elements; isotopes of oxygen, hydrogen, helium, and carbon; tritium; and dissolved gases of helium, neon, and hydrogen. The data were collected to help determine the fraction of young water in the ground water.

DOE/ID–22165 Chemical and radiochemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1997–98, OFR 00–236, by R.C. Bartholomay, L.L. Knobel, B.J. Tucker, and B.V. Twining, 2000, 52 p. This is the sixth in the series of reports describing water quality of samples from wells in the vicinity of the Naval Reactors Facility at the INEEL. Results are presented for samples collected quarterly from 13 wells during 1997–98. Samples were analyzed by Quantera Environmental Services (as part of the U.S. Department of Defense Environmental Conservation Program) for dissolved chloride and sulfate, total cations, total trace elements, nutrients, total organic carbon, total organic halogens, gross alpha- and beta-particle radioactivity, strontium-90, tritium, and gamma-emitting radioisotopes, volatile organic compounds, and base/neutral organic compounds. Fourteen quality-assurance samples also were collected.

DOE/ID–22166 In situ production of chlorine-36 in the eastern Snake River Plain aquifer, Idaho: implications for describing ground-water contamination near a nuclear facility, WRIR 00–4114, by L.D. Cecil, L.L. Knobel, J.R. Green, and S.K. Frape, 2000, 35 p. This report presents the calculated contribution to ground water of natural, in situ produced chlorine-36 in six major water-bearing rock types present in the eastern Snake River Plain and compares these concentrations with measured concentrations in water from wells at and near the INEEL. The estimated maximum corrected concentrations of chlorine-36 in ground water

associated with the six rock types ranged from 2.45×10^5 atoms/L for ground water in basalt to 7.68×10^6 atoms/L for ground water in rhyolite. These concentrations are at least seven orders of magnitude smaller than measured in water from wells at and near the INEEL. This study showed that in situ production of chlorine-36 was insignificant compared with concentrations measured in ground water near the INEEL.

DOE/ID–22167 Hydrologic conditions and distribution of selected constituents in water, Snake River Plain aquifer, Idaho National Engineering and Environmental Laboratory, Idaho, 1996 through 1998, WRIR 00–4192, by R.C. Bartholomay, B.J. Tucker, L.C. Davis, and M.R. Greene, 2000, 52 p. This is the ninth in a series of reports covering the effects of waste disposal on the distribution of constituents in the Snake River Plain aquifer. The report presents an analysis of water-level and water-quality data collected during 1996 through 1998. Water levels increased (more than 6 ft north of NRF) during this period because of increased recharge. Tritium concentrations continued to decrease in the aquifer, as much as 9.3 pCi/mL in water from one well, as a result of decreases in waste disposal, radioactive decay, and changes in disposal methods. No tritium concentrations were greater than the maximum contaminant level for drinking water. Concentrations of all gamma-emitting isotopes and plutonium isotopes were less than the reporting level. Most of the changes in ion concentrations represented increases or decreases in waste-disposal rates.

DOE/ID–22168 Distribution of selected radiochemical and chemical constituents in perched ground water, Idaho National Engineering and Environmental Laboratory, Idaho, 1996–98, WRIR 00–4222, by R.C. Bartholomay and B.J. Tucker, 2000, 51 p. This is the fourth in the series of reports covering the effects of waste disposal on the distribution of constituents in perched-water zones at the INEEL. This report presents an analysis of water-level and water-quality data collected during 1996–98 for samples from wells completed in perched ground water at the INEEL. The report presents the results for tritium, strontium-90, gross gamma, chromium, sodium, chloride, sulfate, and nitrate from perched-water wells at the TRA and the INTEC (formerly the ICPP) and results for purgeable organic compounds, plutonium, and americium from well USGS 92 at the RWMC. The largest tritium concentration in 1998 in deep perched ground water at the TRA was 116±4 pCi/mL. Variability in tritium concentrations was related to variable disposal rates, distance of wells from the warm-waste ponds, depth to water, discontinued use of the warm-waste ponds at the TRA in 1993, radioactive decay, and dilution from nonradioactive water. Tritium concentrations in water from wells near the INTEC decreased because of decreased disposal rates. Most of the ion concentrations represented increases or decreases in disposal rates. Concentrations of all radionuclides in samples from well USGS 92 were less than the reporting levels. Fourteen purgeable organic compounds were detected in water from well USGS 92.

DOE/ID–22169 Radiochemical and chemical constituents in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 1999, OFR 00–399, by R.C. Bartholomay, B.V. Twining, and L. J. Campbell, 2000, 30 p. This is the eleventh in a series of data reports describing the water quality of the Snake River Plain aquifer between the INEEL and the Hagerman area. Water samples were collected from 19 sites during August of 1999 as part of Round 5 of the study. Samples were analyzed for tritium, strontium-90, gross alpha and beta, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22170 Measurement of hydraulic properties of the B-C interbed and their influence on contaminant transport in the unsaturated zone at the INEEL, WRIR 00–4073, by K.S. Perkins, and J.R. Nimmo, 2000, 30 p. The physical and hydraulic property measurements made for this study enhanced the understanding of hydrologic processes in the B-C sedimentary interbed. The report presents data for measurements of bulk density, particle density, particle-size distributions, soil-moisture retention, saturated hydraulic conductivity, and hydraulic conductivity as a function of water content.

DOE/ID–22171 Hydrological and meteorological data for an unsaturated-zone study area near the Radioactive Waste Management Complex, Idaho National Engineering and Environmental Laboratory, Idaho, 1997–99, OFR 00–248, by K.S. Perkins, 2000, 18 p., one compact disc. This report is the last in a series of five data reports that provide information for estimating the potential for migration of radionuclides in the unsaturated zone at the RWMC. The report describes the final phase of a multiphase study of the geohydrology of the RWMC. The report presents hydrologic and meteorological data collected during 1997-99 at a designated test trench area established by the USGS in 1985 adjacent to the northern boundary of the RWMC Subsurface Disposal Area. During 1997–99, soil-moisture content was measured approximately monthly in 13 neutron-probe access holes using a neutron moisture gage. Meteorological data collected at the test trench area during 1997–98 included air temperature, precipitation, net radiation, wind speed, wind direction, soil-surface temperature, soil-heat flux, and relative humidity.

DOE/ID–22172 Chemical and radiochemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering and Environmental Laboratory, Idaho, 1999, OFR 01–27, R.C. Bartholomay, L.L. Knobel, B.J. Tucker, and B.V. Twining, 2001, 37 p. This is the seventh in the series of reports describing water quality of samples from wells in the vicinity of the Naval Reactors Facility at the INEEL. Results are presented for samples collected quarterly from 13 wells during 1999. Samples were analyzed for dissolved chloride and sulfate, total cations, total trace elements, nutrients, total organic carbon, total organic halogens, gross alpha- and beta-

particle radioactivity, strontium-90, tritium, gamma-emitting radioisotopes, volatile organic compounds, and base/neutral organic compounds. Fourteen quality-assurance samples were also collected. Severn Trent Laboratories, as part of the USGS Department of Defense Environmental Conservation Program, analyzed samples for all constituents except tritium, which was analyzed by the University of Georgia.

DOE/ID–22173 Chemical composition of selected solid-phase samples from the Snake River Plain aquifer system and contributing drainages, eastern Idaho and western Wyoming, OFR 01–36, L.L Knobel, L.D. Cecil, S. Fisher, and J.R. Green, 2001, 20 p. This report presents chemical compositions of 25 solid-phase samples from the eastern Snake River Plain aquifer system and contributing drainages. Seven samples were collected from selected depths from 6 coreholes from the INEEL and 18 samples were collected from outcrops in recharge areas of the Snake River Plain aquifer. Ten major elements, as many as 28 trace elements, and the amount of volatile material were determined for each sample.

DOE/ID–22174 Geochemistry of the Big Lost River drainage basin, Idaho, WRIR 01–4031, C. Carkeet, J.J. Rosentreter, R.C. Bartholomay, and L.L. Knobel, 2001, 31 p. The purpose of this study was to better define the geochemical character of water in the Big Lost River drainage basin and to determine its effect on the geochemistry of the Snake River Plain aquifer at and near the INEEL. Water samples were collected from 10 wells for analysis of selected inorganic constituents, dissolved organic carbon, stable isotopes, tritium, and selected gross measurements of radioactivity. Results showed that water from the Big Lost River drainage basin has a calcium-magnesium bicarbonate character and that the dominant chemical reactions in the basin involve water and calcite, dolomite, and carbon dioxide gas. Water from the Arco City well, the farthest downgradient well in the basin from which samples were collected, was geochemically modeled from water in the upgradient wells.

DOE/ID–22175 Radiochemical and chemical constituents in water from selected wells south of the Idaho National Engineering and Environmental Laboratory, Idaho, OFR 01-138, R.C. Bartholomay, B.J. Tucker, L.L. Knobel, and L.J. Mann, 2001, 19 p. This report presents results of analyses of water samples collected in 1993 from five stock wells on Bureau of Land Management property south of the INEEL. The water samples were analyzed for selected radionuclides, stable isotopes, common ions, trace elements, nutrients, and purgeable organic compounds.

DOE/ID–22176 Radiochemical and chemical constituents in water from selected wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman area, Idaho, 2000, OFR 01-358, by R.C. Bartholomay, B.V. Twining, and L.J., Campbell, 2001, 33 p. This is the twelfth in the series of data reports describing the water quality of the Snake River Plain aquifer between the INEEL and the Hagerman area. Water samples were collected from 18 sites during 2000 as part of Round 5 of the study. Samples were analyzed for tritium, strontium-90, gross alpha and beta, gamma-emitting radionuclides, trace elements, common ions, nutrients, purgeable organic compounds, insecticides, polychlorinated compounds, and herbicides.

DOE/ID–22177 Estimated age and source of the young fraction of ground water at the Idaho National Engineering and Environmental Laboratory, WRIR 01-4265, by E. Busenberg, L.N. Plummer, and R.C. Bartholomay, 2001, 144 p. This report presents the results of a study that used concentrations of chlorofluorocarbons, sulfur hexafluoride, helium, and tritium to determine the estimated age of the young fraction of ground water at and near the INEEL. In addition, concentrations of fluoride, boron, lithium, strontium, dissolved atmospheric gases, helium, and tritium, and stable oxygen isotope ratios were used to determine the sources of water in the Snake River Plain aquifer at and near the INEEL.

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Knobel and others

Historical Development of the U.S. Geological Survey Hydrologic Monitoring and Investigative Programs at the Idaho National Engineering and Environmental Laboratory, Idaho, 1949 to 2001

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